Model SRM-200

Smart Radiation Monitor Technical Manual

SALES

Eberline *A subsidiary of*
Thermo Instrument
Systems Inc.

P.O. Box 2108
Santa Fe, New Mexico 87504-2108
(505) 471-3232 TWX: 910-985-0678

Price List

Repair Calibration

EFFECTIVE January 1, 1991
Prices are F.O.B. Santa Fe, New Mexico
Subject to change without notice
Terms: ¾ of 1% 10, net 30 days
Minimum order $40.00

The prices quoted herein do not include state, gross receipts, or local sales tax. The tax will be added as a separate item in the event that the transaction is determined to be taxable.

Eberline *A subsidiary of* **Thermo Instrument** *Systems Inc.*

P.O. Box 2108
Santa Fe, New Mexico 87504-2108
(505) 471-3232 TLX: 66-0438 EIC SFE
FAX: (505) 473-9221

GENERAL INFORMATION

Instruments for repair or calibration should be packaged, marked, or otherwise prepared in accordance with good commercial practices and shipped F.O.B. destination freight prepaid to one of the Eberline facilities below.

Repair and Calibration Facilities

Eberline Instrument Corporation
504 Airport Road
Santa Fe, NM 87504-2108
Attn: Western Service Center
(505) 471-3232
1-800-274-4212

Eberline Instrument Corporation
312 Miami Street
West Columbia, SC 29169
Attn: Eastern Service Center
(803) 822-8843
1-800-234-4212

Normal turn-around time for repair (Eberline instruments) is fifteen working days.

Normal turn-around time for calibration (Eberline instruments) is seven working days.

Prices (Subject to change without notice)

Certified calibration (Eberline portable instruments)(2 points/range)	
Unit and one probe	$90.00
Second probe	45.00
Third or fourth probe (Limited to 4 probes per instrument)	25.00
Certified calibration (other manufacturer's portable instruments)	90.00
ALPHA-3, ALPHA-5, AMS-3, HFM's, Portal Monitors, RM-22, SAM-2, WLM-1A, ESP-2 6112B, 6112D (certified calibration)	145.00
RGM-2 (certified calibration)	405.00
RGM-3 (certified calibration)	235.00
As found readings on any of the above, a charge of 50% of calibration rate shall be made.	
Calibrate "non-removeable" contaminated instruments	QUOTE
Services Contracts (Eberline equipment)	QUOTE
Technical Specification writing and Consultation	QUOTE
Service Engineer at Customers Site	$880.00/day plus expenses at cost +10% adm.
-Over 8 hours or Saturday and Sunday	165.00/hr
-Eberline Holidays	220.00/hr
Consulting	925.00/day
Repair rate (plus calibration and parts at list price)	85.00/hr
Repair "non-removeable" contaminated instruments	95.00/hr
Expediting Fee	50.00/ instrument
Accredited secondary standards laboratory calibration (Cs^{137} and Co^{60} photon)	QUOTE

Note: Repair and Calibration time on non-Eberline instruments is subject to availability of parts and literature for the specific instrument.

Repair or Calibration Warranty

Eberline warrants to replace or repair, at its option, any repaired products or replaced parts thereof (excluding tubes, crystals, batteries and normal consumables) which are found defective in material or workmanship within ninety (90) days from date of repair or the balance of the new purchase warranty, whichever occurs later. Instruments calibrated by Eberline are warranted to be within specified limits at time of shipment. In the event of calibration error, Eberline will again calibrate the instrument without charge to the instrument owner. The aforesaid warranty does not cover life-end failure of components and will be voided if repair has been attempted by other than seller's authorized personnel. In no event shall Eberline be liable for consequential or special damages, transportation, installation, adjustment, work done by customer or other expenses which may arise in connection with such defective product or parts.

Exclusion of Warranties and Limitation of Liability

The foregoing warranty is expressly made in lieu of any and all other warranties express or implied including the warranties of merchantability and fitness for a particular purpose. Under no circumstances shall seller be liable for any indirect, special, incidental, or consequential damages to customer or to any third party.

SRM-200

TABLE OF CONTENTS

Page

I. GENERAL 1

- A. DESCRIPTION 1
- B. SPECIFICATIONS 4

II. OPERATING INSTRUCTIONS 1

- A. INTRODUCTION 1
  - 1. General 1
  - 2. Access Levels 3
  - 3. Data Logging Features 5
  - 4. Automatic Detector Configuration 7
  - 5. Factory Calibration 7
  - 6. Description of Controls 8
- B. PREPARATION FOR USE AND OPERATIONAL CHECK 13
  - 1. Set Up the SRM-200 and Detector 13
  - 2. Turn the instrument "On" or "Off" 13
  - 3. Determine Battery Level 14
  - 4. Example Setup 14
- C. OPERATION IN THE RATEMETER MODE 14
  - 1. Analog Bar Graph 15
  - 2. Numerical Value of Count Rate 15
  - 3. Accuracy, Precision and Response Time 15
  - 4. Alarm 16
  - 5. Over Range Indication 16
  - 6. Storing Readings in Ratemeter Mode 16
  - 7. Operating in the Peak Trap Ratemeter Mode 17
- D. OPERATION IN SCALER MODE 17
  - 1. Average Rate Scaler Mode 18
  - 2. Integrating Scaler Mode 19
  - 3. Fixed Precision Scaler Mode 20
  - 4. Storing Data in a Scaler Mode 21
- E. USING THE OPERATE MODE 22
  - 1. Entering the Operate Mode 22
  - 2. System Level Parameters 22
- F. USING THE CLOCK MODE 25
- G. USING THE PARAMETERS MODE 26
  - 1. Selecting Detectors 26
  - 2. Selecting Operating Modes 27
  - 3. Changing Units 29
  - 4. Changing Alarm Setting 31
  - 5. Setting the Calibration Constant (CC) 32
  - 6. Setting the Dead Time (DT) 33
  - 7. Setting the High Voltage for the Detector of Choice 34
  - 8. Changing Count time (Scaler Mode) 36

SRM-200

TABLE OF CONTENTS

Page
- H. USING THE LOG MODE 36
  - 1. Entering the Log Mode and Stepping through the Menu 37
  - 2. Changing Output Format and Baud Rate 38
  - 3. Transferring Log Data to a Printer 39
  - 4. Displaying Log Data 41
  - 5. Resetting Log Data 41
- I. SIMPLE TROUBLESHOOTING 43

III. FUNCTIONAL FLOW DIAGRAMS 1

IV. THEORY OF OPERATION 1

- A. GENERAL 1
- B. FUNCTIONAL THEORY 1
  - 1. Detector 1
  - 2. High Voltage Supply 1
  - 3. Amplifier/Discriminator 1
  - 4. Speaker/Alarm 1
  - 5. Microcomputer 2
  - 6. Low Voltage Supply 2
  - 7. DC Power Supply 2
  - 8. RS-232 Driver 2
  - 9. Clock Circuit 2
- C. OPERATIONAL THEORY 2
  - 1. DC Power Supply 2
  - 2. Low Voltage Power Supply 3
  - 3. Operation on Battery Backup 3
  - 4. High Voltage Power Supply 3
  - 5. Amplifier/Discriminator 4
  - 6. Alarm Relay Contacts 5
  - 7. Speaker 5
  - 8. Keyboard 5
  - 9. Microcomputer 6
  - 10. Optional PHA Circuit 9

V. MAINTENANCE 1

- A. CALIBRATION 1
  - 1. General 1
  - 2. DC Power Supply 1
  - 3. High Voltage 1
  - 4. Instrument/Detector Quality 2
  - 5. Ratemeter Calibration 6
- B. CALIBRATION WITH PHA 7

SRM-200

TABLE OF CONTENTS

Page

C. PREVENTIVE MAINTENANCE 12
  1. Periodic Maintenance 12
D. CORRECTIVE MAINTENANCE 12
  1. Disassembly/Assembly 12
  2. Troubleshooting 14

VI. PARTS LIST 1
  1. PC Board Set (2 boards plus display) EIC #YP11384000 1
  2. ESP-2 PC Board EIC #YP11385000(0) 7
  3. DC Power Supply Board EIC #YP11341000(3) 8
  4. Miscellaneous Parts 9
  5. SRM-200 Options 11

VII. DIAGRAMS 1

VIII. DETECTORS AND ACCESSORIES 1

LIST OF TABLES

2-1. SRM-200 Access Levels, 11383-C31 6
5-1. Suggested Calibration Levels 3
5-2. Input Sensitivity vs. Threshold Voltage 4
5-3. Calculating Calibration Constant 7
5-4. Check Voltages 16
8-1. Detectors Recommended for Use with SRM-200 1

LIST OF ILLUSTRATIONS

1-1. Model SRM-200 3
2-1. External Controls and Display. 9
2-2. Internal Controls 12
2-3. SRM-200/Printer Cable Interconnection Diagram 39
2-4. Printer Heading and Data Format 42
3-1. Normal Ratemeter Mode 2
3-2. Peak Trap Ratemeter Mode 3
3-3. Fixed Precision Scaler Mode 4
3-4. Fixed Precision Scaler Mode with Auto-recycle, Auto-store, and Auto-log 5
3-5. Integrating Scaler Mode 6
3-6. Integrating Scaler Mode with Auto-recycle, Auto-store, and Auto-log 7
3-7. Average Rate Scaler Mode 8
3-8. Average Rate Scaler Mode with Auto-recycle, Auto-store, and Auto-log 9
3-9. Clock Mode 10
3-10. Operate Mode 11
3-11. Parameters Mode 12
3-12. Selecting Units 13
3-13. Selecting Detectors 14
3-14. Selecting Operating Modes 15
3-15. Log Mode 16
3-16. Selecting Enhanced Store Functions 17
3-17. Ratemeter Mode with Enhanced Store Functions 18
3-18. Fixed Precision Scaler Mode with Enhanced Store Functions 19
3-19. Fixed Precision Scaler Mode with Enhanced Store Functions, Auto-Log, and Auto-recycle 20
5-1. Typical Detector Plateau 5
5-2. Typical PHA Operating Curves 10
5-3. SRM-200 with Bottom Cover Removed 11
7-1. Functional Block Diagram, Microcomputer 2
7-2. Functional Block Diagram, Amplifier, High Voltage and Speaker 3
7-3. Functional Block Diagram, Low Voltage 4
7-4. Component Layout, ESP Basic PC Board Assembly 5
7-5. Component Layout, ESP-2 PC Board Assembly 6
7-6. Component Layout, SRM-200 PHA PC Board Assembly 7
7-7. Component Layout DC Power Supply Board 8
7-8. Amplifier High Voltage and PHA Schematic 9
7-9. Microcomputer Schematic 10
7-10. ESP-2 PC Board Schematic 11
7-11. DC Power Supply Schematic 12
7-12. Wiring Diagram, SRM-200 13
7-13. Wiring Diagram, SRM-200 PHA Option 14

Section 1

SECTION I. GENERAL

A. DESCRIPTION

The Smart Radiation Monitor (SRM-200) is a line powered, data logging, microcomputer-based, bench-top radiation survey instrument designed to operate with most Eberline radiation detectors. It is designed to be used for routine radiation measurements and allows multiple readings, up to 500, to be stored and later output to a computer or a printer. The SRM-200 may also be used in remote areas, operated solely by a computer via its RS-232 serial communications port. The SRM-200 is functionally the same as an ESP-2 except it has a line powered power supply and is housed for bench-top operation versus being portable.

The SRM-200 features a liquid crystal display (LCD) along with a single row of six multi-function pushbutton switches as its interface to the user. Also, it features a built-in speaker which produces audible "clicks" and alarm signal when readings have exceeded a preset value. Data are presented in either scientific or floating point notation and have selectable measurement units. Complete detector configuration including HV setting, calibration, and operating mode can be specified for up to three different detectors and stored by the SRM-200. This makes changing detectors a simple matter of disconnecting the old detector, specifying (by name) the new detector, and then connecting the new detector. No internal adjustments are required making the SRM-200 an ideal instrument for multi-detector kits.

Power for the SRM-200 is supplied by an AC line or an internal rechargeable battery when away from AC power. The battery is continuously trickle charged whenever the unit is plugged into an AC line. 115 Vac or 230 Vac is switch selectable.

A powerful feature of the SRM-200 is Enhanced Store operation. Multiple detector configurations up to three, can be switched between automatically while only one detector is connected to the instrument. This mode allows the user to tailor the "MODE/STORE" key to fit his particular application. For example, the three detector configurations could be calibrated so that the specified high voltage setting centered the PHA windows on peaks from three different isotopes. An Enhanced Store Mode could be selected which, upon pressing the "MODE/STORE" key, store the current reading, download the next set of parameters, and continue operation. Thus, three readings could be stored and uniquely identified on the output. A more common use is to configure "MODE/STORE" to store the current reading and continue operation.

The SRM-200 has two basic operating modes, Ratemeter and Scaler. There are also four "utility" modes which allow the user to configure the data logging, to output data, to set operating parameters, and to set the clock. These routines make extensive use of menus and descriptive prompts which make it simple to setup and operate the instrument.

In operation, the detector signal is input to the computer and converted to count rate. The basic unit is counts per second. The Ratemeter Mode provides the operator with a dual representation of count rate, a bar graph, the length of which is proportional to the activity at the detector, and a numerical value expressed in the applicable radiation units. An audible alarm feature alerts the operator when the alarm setting has been exceeded. To enhance accuracy, the SRM-200 provides both a slow and a fast range of time responses, each of which varies automatically with count rate.

The Scaler Mode, Integrating or Average Rate, allows the operator to select a counting period over which the computer integrates the detector's signal. In the Scaler Mode the first line of the LCD displays the time remaining in the counting period. The second line shows cumulative "events". At the end of the counting period, the instrument displays the length of the counting period and the total number of events or radiation units detected, or if in the Average Rate Mode, will display the average rate for the period shown. If Fixed Precision (2, 5, 8, or 10 percent) is set, the instrument integrates the detector signal for whatever time is required for the selected precision and displays the average rate. Both the time and the number of counts or average rate are displayed at the end of the cycle. The instrument features manual store or auto-store, manual reset or auto-recycle, and manual or auto-cycle output while in the Scaler Mode.

An important feature of the SRM-200 is that logging information such as date, time, instrument number, user ID, detector selected, operating mode, and calibration parameters, are all output as a heading to the stored data. Along with each data point output are the date, time, location code and instrument status.

This instrument should be especially useful to personnel associated with radiation safety offices, health physics offices, nuclear medicine departments, research laboratories, or any application where multiple radiation measurements are required. Furthermore, requirements for hard-copy records for legal documentation of measurements can be provided which offer a record of instrument operating conditions as well as the data, user I.D., and date and time of measurement.

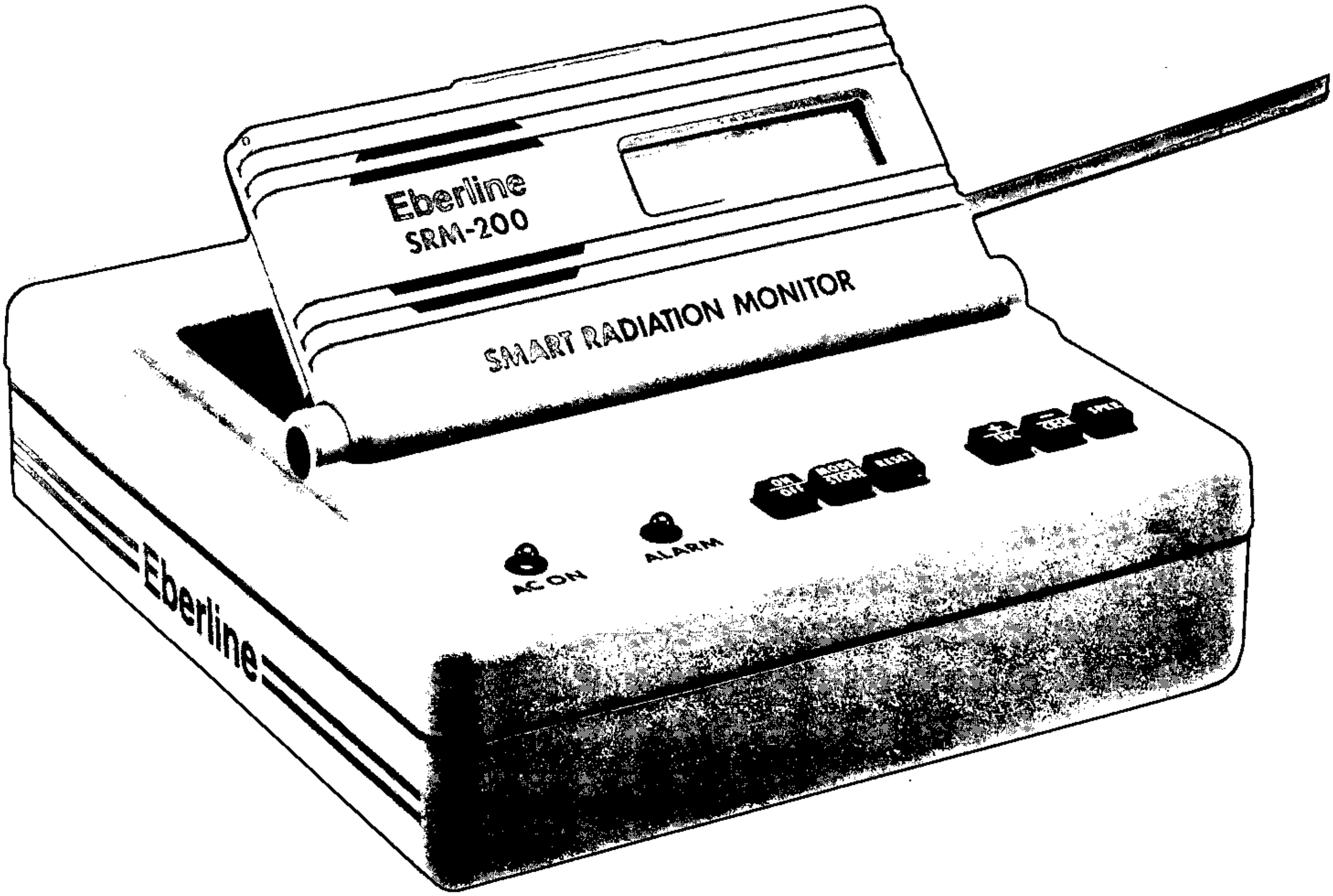


Figure 1-1, Model SRM-200

B. SPECIFICATIONS

1. Mechanical (with batteries, excluding probe):

   a. Overall Dimensions: W = 7.5 in. (19 cm), D= 8.2 in. (20.8 cm), H = 3.1 in. (7.9 cm) with display closed, 5.2 in. (13.2 cm) with display fully open.

   b. Weight: Approximately 3.6 lb. (1.64 kg).

2. Temperature:

   Operating: -20°C to +50°C (-4°F to 122°F)

   Storage: -30°C to +80°C (-22°F to 176°F)

3. Voltages:

   a. Low Voltage: 5 Vdc.

   b. High Voltage (detector bias voltage): 500 to 2450 Vdc, adjustable from the keypad.

   c. DC Power Supply Voltage: 6.85 Vdc.

4. Detectors:

   Most Eberline GM, proportional, or scintillation detectors for alpha, beta, gamma, or neutron activity may be used on the SRM-200. The detectors recommended are described in Section VIII. The detectors connect to the SRM-200 via an MHV-series coaxial connector located on the rear of the instrument.

5. Readout:

   a. Two lines of 16 alphanumeric characters presented on liquid crystal display (LCD).

   b. Character size: H = 0.175 inch (4.45 mm); W = 0.124 inch (3.15 mm).

   c. Bar graph resolution: 1 in 48 (2.1 percent).

6. Response Time:

   Variable from 1 to 30 seconds (measured to 90 percent of final reading).

7. Alarm:

   a. For Ratemeter and Scaler Operating Modes.

   b. A 2000-Hz audio tone from the speaker.

   c. Visual: Red LED on front cover.

d. External Alarm Contacts: Available on the rear panel. Rated at 2A, up to 240 Vac or 28 Vdc. Contacts are labeled C (common), NO (normally open), NC (normally closed). The normal state is alarm indicator off, relay de-energized.

8. External Controls (Refer to Section II.A.6. for Detailed Functional Description):

A single row of six 3/8-inch-square pushbutton switches across the face of the instrument. From left to right, they are:

a. ON/OFF: Press on - press off

b. MODE/STORE: Press on - normally off

c. RESET: Press on - normally off

d. +/INC: Press on - normally off

e. -/CRSR: Press on - normally off

f. SPKR: Press on - press off

9. Internal Controls (Refer to Section II.A.6. for Detailed Functional Description):

The internal controls consist of five potentiometers and seven switches accessible by removing the back cover. They are:

a. GAIN: Potentiometer
b. THRESHOLD: Potentiometer
c. HV LEVEL: Potentiometer
d. HV GAIN: Potentiometer
e. SPEAKER divide by 1: One switch ON/OFF
f. SPEAKER divide by 16: One switch ON/OFF
g. SPEAKER divide by 64: One switch ON/OFF
h. SPEAKER divide by 256: One switch ON/OFF
i. TEST: Switch
j. RESET: Press on - normally off (accessible with bottom cover removed)
k. SPKR ON/OFF: Slide switch
l. LV ADJ: Potentiometer
m. LINE SELECT SWITCH: 115/230 VAC

10. Power:

a. Line: 115 or 230 Vac - switch selectable; 50/60 Hz, 1/8 Amp.

b. Battery: 6V, 1 Amp-hour Gel-type battery, continuously trickle charged with instrument plugged into line.

c. Battery Life: Minimum 30 hours, with speaker on and no alarm. Typically 60 hours.

Minimum 12 hours, with speaker off and alarm on. Typically 18 hours.

Minimum 2 hours, with speaker and alarm on (worst case). Typically 4 hours.

11. Mounting:

Provisions have been made for wall mounting if other than bench-top use is desired. The mounting holes are accessed by removing the two back feet closest to the AC power cord and detector connector. These holes will accommodate 1/4" binder head or pan head screws. The mounting holes are on 4 13/16" centers. If desired, the other two feet may also be removed.

12. RS-232 Serial Input/Output Communications Port:

a. Number of data bits: 8

b. Parity: None

c. Number of stop bits: 1

d. Number of start bits: 1

e. Baud Rate (User Selectable): 150, 300, 600, 1200, 2400, 4800, 9600

f. Hardware Handshakes: DATA TERMINAL READY - OUTPUT
REQUEST TO SEND - OUTPUT
DATA SET READY - INPUT

g. Software Handshakes: Eberline document 13000-A08, ESP-2 Communication Specification, is available upon request and contains a detailed description of the software handshaking protocol.

h. Connector: D subminiature, 9 pin female

i. Logic Levels: ±9V No load

13. Data Storage:

8K RAM (approximately 500 data points). Not erased after data output.

14. Data Logging Heading:

Date, Instrument Number, User I.D., Detector Number, Mode, Calibration Constant, Dead Time, High Voltage

15. Data:

    Date-time, Location, Reading, Instrument Status

16. Operating Modes:

    Ratemeter:

    a. Normal (fast or slow time constant)

    b. Peak Trap (fast or slow time constant)

    Scaler:

    a. Fixed Precision 2, 5, 8, or 10 percent

    b. Integrating

    c. Average Rate

17. Data Logging in Ratemeter Mode:

    a. Manual store and manual output.

    b. Enhanced store.

18. Data Logging in Scaler Mode:

    a. Manual reset, manual store and manual output.

    b. Auto-recycle, auto-store, and manual output.

    c. Auto-recycle, auto-store, and auto-output.

    d. Enhanced store.

19. Utility Modes:

    a. Log

    b. Operate

    c. Parameters

    d. Clock

20. Multiple Detectors:

    Allows user to preset operating parameters for up to three detectors. Detectors can be switched and operation with a new detector is as simple as selecting the detector by user defined identification (up to 13 characters).

21. Communication Formats:

    a. Printer (Output Only)

    b. Computer I/O (see ESP-2 Communication Specification, EIC #13000-A08.)

22. Microcomputer:

    a. CPU: Intel 80C31

    b. External RAM: 8,192 bytes

    c. EPROM: 16,384 bytes

23. RS-232 Cable Options:

    CA-40-80, ESP-2 to printer.
    CA-41-80, ESP-2 to IBM-AT computer.
    CA-42-80, ESP-2 to IBM-PC computer.

24. Demo Software Option:

    YP11383011, ESP-2 Demo Software (includes ESP-2 Communication Specification, EIC #13000-A08).

25. PHA Option (EIC YP11395047):

    This is a factory installed option at the time of purchase. A Pulse Height Analyzer (PHA) PC board may be purchased separately and plugged into the existing circuitry, providing pulse height discrimination capability. The PHA "window" and "threshold" are externally and continuously adjustable with 10 turn potentiometers. An external mounted switch is supplied with the option which selects between GROSS and PHA operation.

Section 2

SECTION II. OPERATING INSTRUCTIONS

A. INTRODUCTION

1. General

This section is intended to provide the user with a guide to what the SRM-200 does and how to operate it. There are also easy to follow functional flow diagrams in Section III which the user is recommended to utilize to step through all the operational modes of the SRM-200.

The SRM-200 is simple and straight-forward in its operation. The basic principle of operation is that the signal from an attached radiation detector is converted to count rate. The SRM-200 can be used either as a Ratemeter or as a Scaler, and a variety of units can be selected for display of the data.

The SRM-200 Ratemeter Mode has two sub modes:

a. The Normal Ratemeter Mode:

- updates and displays selected units per time, such as counts per minute or mR/h;
- provides the operator with a dual representation of count rate; that is, it provides a moving analog bar graph representing count rate and also a digital value for count rate;
- alarms when an adjustable preset value is exceeded.

The Ratemeter Mode is generally used for routine surveys of surfaces, personnel or clothing for either contamination or exposure rate measurements from a radioactive source.

b. The Peak Trap Ratemeter Mode:

- is same as normal Ratemeter Mode except for the following additional functions:
- retains in a memory buffer the peak value of the ratemeter reading since the last "STORE" or "RESET";
- the peak count rate is transferred from the memory buffer to the data logging memory when a manual store is performed.

This mode is useful in searching for the highest level of radioactivity, a radioactive "hot spot".

The Scaler Mode may be used for quantitative data accumulation over a selectable period of time. Using the Scaler Mode, comparisons can be made of radioactivity in various samples or situations with increased accuracy in the data over that obtained with the Ratemeter Mode.

The SRM-200 Scaler Mode has three sub modes:

a. The Scaler Integrating Mode:

- allows setting the time interval over which counts or events are to be accumulated;

- registers the number of events or integrated exposure in the selected time interval;

- sounds the audible alarm if the integrated measurement in the selected time period exceeds the alarm setting.

b. The Scaler Average Rate Mode:

- same as the Scaler Integrating Mode except that the average rate is continuously displayed and updated.

c. The Scaler Fixed Precision Mode:

- automatically adjusts count time so that the measurement has a selectable fixed precision (2, 5, 8, or 10 percent at the 2 sigma confidence level).

The SRM-200 has four "utility" modes. These are the Log, Operate, Parameters, and Clock Modes. They are referenced as "utility" modes because they are not used in making measurements, but as "aids" or "utility" to the measurement modes. These modes assist in transferring data, changing detectors, setting calibration parameters, reading and setting the clock, etc.

The four utility modes are:

a. Clock Mode:

- allows the user to read and set the clock.

b. Parameters Mode:

- allows the user to select one of three detectors for use with the instrument; (A group of predefined parameters is used to configure each of the detectors.)

- allows the user to select the name or label given to the detector;

- allows the user to select the particular operating mode;

- allows the user to set the value of high voltage;*

- allows the user to set the dead time;*

- allows the user to set the calibration constant;*

- allows the user to set the alarm level;

- allows the user to select the count time for the Scaler Mode.

*These items are determined at time of calibration of the SRM-200 with a detector. Refer to Section IV and V.

c. The Operate Mode:

- allows the user to view or change the access level;

- allows the user to view or change the user I.D. number;

- allows the user to view or change the instrument number.

- allows the user to select the default or Enhanced Store Mode. The following options are available if the Enhanced Store Mode is enabled:

- allows the user to select manual or automatic selection of different detector configuration parameters (e.g. high voltage, dead time, calibration constant, units, mode, etc.) while using a single detector. This is useful with the PHA option for changing high voltage to shift the window energy or for simply distinguishing between PHA gross measurements made at the same location. Window open/window closed measurements with a beta-sensitive probe can be identified this way as well.

- allows the user to manually or automatically store data with a single key stroke.

- allows the user to select either manual or automatic increment of the location code when a "STORE" is executed.

- allows the user to set a pause of one to five seconds during the auto-store operation. This allows time for the user to view and/or change the location code number before the SRM-200 stores it.

d. The Log Mode:

- allows the user to display the stored data;

- allows the user to transfer the stored data to a printer or a computer via the RS-232 serial communications port;

- allows the user to "reset" or "erase" all data points stored in the data log memory;

- allows the user to select the baud rate for the RS-232 communications;
- allows the user to select the communications format.

2. Access Levels

The SRM-200 has access levels programmed into its software. These access levels provide for control of access to the instruments calibration parameters. There are five access levels, 0-4. The higher the access level setting, the more the user can change calibration features or control operating features of the instrument. At the lower access levels, fewer functions and displays are controllable by the user. Table 2-1 summarizes the access levels. Access levels may be changed in the Operate Mode as described in Section II.E. The following define the functions which may be performed with the SRM-200 at a given access level:

a. Access level 0:

- the user may observe measurement values for the particular operating mode the instrument is in; (He may not change modes or any parameters, etc.)

- the user may store readings;

- the user may edit the location codes associated with each particular reading;

- the user may observe and change the instrument access level while in the Operate Mode. (The user must know the key code in order to change the access level.)

b. Access level 1:

- the user may perform everything in access level 0;

- the user may view stored data on the display;

- the user may transfer data in the Log Mode;

- the user may change the user I.D. number in the Operate Mode;

- the user may change the count time in the Parameters Mode;

- the user may change the alarm setting in the Parameters Mode;

- the user may read the clock in the Clock Mode.

c. Access level 2:

- the user may perform everything in access levels 0 and 1;

- the user may select detectors in the Parameters Mode;

- the user may reset or erase the data log memory in the Log Mode.

d. Access level 3:

- the user may perform everything in access levels 0, 1, and 2;

- the user may set the clock in the Clock Mode;

- the user may change operating modes in the Parameters Mode.

e. Access level 4:

- the user may perform everything in access levels 0 through 3.

- the user may change the baud rate and/or select the communication format in the Log Mode;

- the user may change the display units, the calibration constant, the dead time and the high voltage in the Parameters Mode;

- the user may change the instrument number (and hence the key code) in the Operate Mode.

3. Data Logging Features

a. Manual Store

This data logging feature requires the user to press the MODE/STORE key in order to log a data point to memory. This can be done in either the Ratemeter or the Scaler Mode. The STORE function will only work following completion of the count cycle in the Scaler Mode. The value stored is "tied" to the current date/time as well as the current location code. The location code can be changed at any time by the user by entering the new six digit identifier.

b. Automatic Store and Automatic Log

This data logging feature may only be used in conjunction with the Scaler Mode. At the completion of the count cycle, the results are logged to memory and the cycle re-started (AUTO-RECYCLE). Associated with this mode is the ability to automatically output each data point to the peripheral (AUTO-RECYCLE/LOG).

ACCESS LEVEL	LOG MODE	OPERATE MODE	PARAMETERS MODE	CLOCK MODE
0	—	CHG. ACCESS LEVEL (SEE NOTE 2)	—	—
1	DISPLAY LOG DATA TRANSFER LOG DATA	CHG. USER I.D. # CHG. LOC CODE #	CHG. COUNT TIME (SCALER MODE) CHG. ALARM SET POINT	READ CLOCK VALUE
2	ZERO LOG DATA (ERASE)	—	CHG. DETECTOR CONFIGURATION	—
3	—	—	CHG. OPERATING MODES	SET CLOCK
4	CHG. BAUD RATE CHG. OUTPUT FORMAT	CHG. INSTRUMENT # (AND KEY) CHG. ENHANCED STORE OR DEFAULT STORE	CHG. UNITS CHG. CAL. CONST. CHG. DEAD TIME CHG. HIGH VOLTAGE	—

NOTES:

1. EACH ACCESS LEVEL CONTAINS THE FUNCTIONS OF ALL LOWER ACCESS LEVELS.
2. IT IS NECESSARY FOR THE USER TO REMEMBER THE INSTRUMENT NUMBER HE ASSIGNS TO HIS ESP-2 AT ACCESS LEVEL 4 IN ORDER FOR HIM TO CHANGE THE ACCESS LEVEL AT ACCESS LEVEL 0.
   THE "PASSWORD" OR KEY # INCLUDES THE INSTRUMENT NUMBER.

Table 2-1
SRM-200 Access Levels, 11383-C31A

4. Automatic Detector Configuration

Up to three sets of detector calibration parameters may be stored in the SRM-200. Thus, any one of three detectors may be used at any given time simply by disconnecting the cable to the detector in use, selecting the set of new detector parameters from the keypad, and then reconnecting the cable to the new detector. Calibration parameters for that detector must already have been input before the new detector is connected to the instrument.

5. Factory Calibration

The SRM-200 is calibrated at the manufacturing facility. If the instrument were purchased with a detector, the correct calibration factors for that detector are already entered at the factory and the instrument is ready for immediate use. Eberline will calibrate each of the detectors (up to three) purchased with an SRM-200 and input those detectors by name in the parameter files. When less than three detectors are ordered, non-used detector parameter files will have default parameters in them. You should verify that these parameters are the same as those supplied on the Calibration Certificate supplied with the detector. Refer to Section III for directions on viewing the parameters.

If a radiation detector were not purchased with the SRM-200 from the factory, the SRM-200 was calibrated generically at the factory rather than for a specific detector. In that case, calibration factors for the detector or detectors of choice will have to be entered into the SRM-200 before it is ready for use.

CAUTION

> Failure to enter the correct parameters for the detector being used may result in erroneous values being presented on the display of the SRM-200.

The parameters which require being set for a particular detector are:

	SECTION
(1) Alarm Point	II.C.4.
(2) Units	II.G.3.
(3) Calibration Constant	II.G.5.
(4) Detector Dead Time	II.G.6.
(5) High Voltage	II.G.7.

The last four are preset at the factory for the detector which was purchased with the SRM-200. The alarm point is set at a high value at the factory and, thus, should be reset to a user determined value if it is desired to use this feature of the instrument. The alarm value may be set to an extraordinary high value to disable the alarm.

Section V provides simple instructions on how to change these items when changing detectors or re-calibrating the instrument.

CAUTION

> The high voltage should be checked or re-adjusted for a new detector, PRIOR to connecting the detector. Failure to do so may result in damage to the detector.

Regulatory agencies generally require routine laboratory calibration of radiation monitors by an approved facility at least once per year. To have your instrument recalibrated return the SRM-200 and detector to the factory in Santa Fe, to the Eberline repair facility in Columbia, South Carolina, or to another approved calibration facility. If your facility has been approved for such calibrations, this may be accomplished by using the procedures given in Section V.A. CALIBRATION.

6. Description of Controls

a. Operator Controls - External (Figure 2-1)

1) ON/OFF: Pressing the switch turns the instrument on or off.

2) MODE/STORE: This is a multi-function switch. Pressing the "MODE/STORE" switch while operating in a Ratemeter Mode will initiate the storing process for logging of a data point. After the location code has been verified to be correct, pressing the "MODE/STORE" switch a second time will store the value in memory and return the instrument back to the Ratemeter Operating Mode. Pressing the "MODE/STORE" switch while operating in one of the Scaler Modes will invoke the display showing the Utility Mode Menu. Pressing the "MODE/STORE" switch while operating in one of the utility modes will return the instrument back to the current operating mode (i.e. ratemeter or scaler).

3) RESET: The functions of the RESET switch depends on the operating mode selected for the instrument.

   a) In Normal Ratemeter Mode: The RESET switch is used to maintain the bar graph on the display.

   b) In Peak Trap Ratemeter Mode: The RESET switch is used to clear the peak trap memory as well as to scale the bar graph on the display.

   c) In Scaler Mode: The RESET switch starts the counts.

   d) Utility Mode Menu: The RESET switch is used to select the Log Mode.

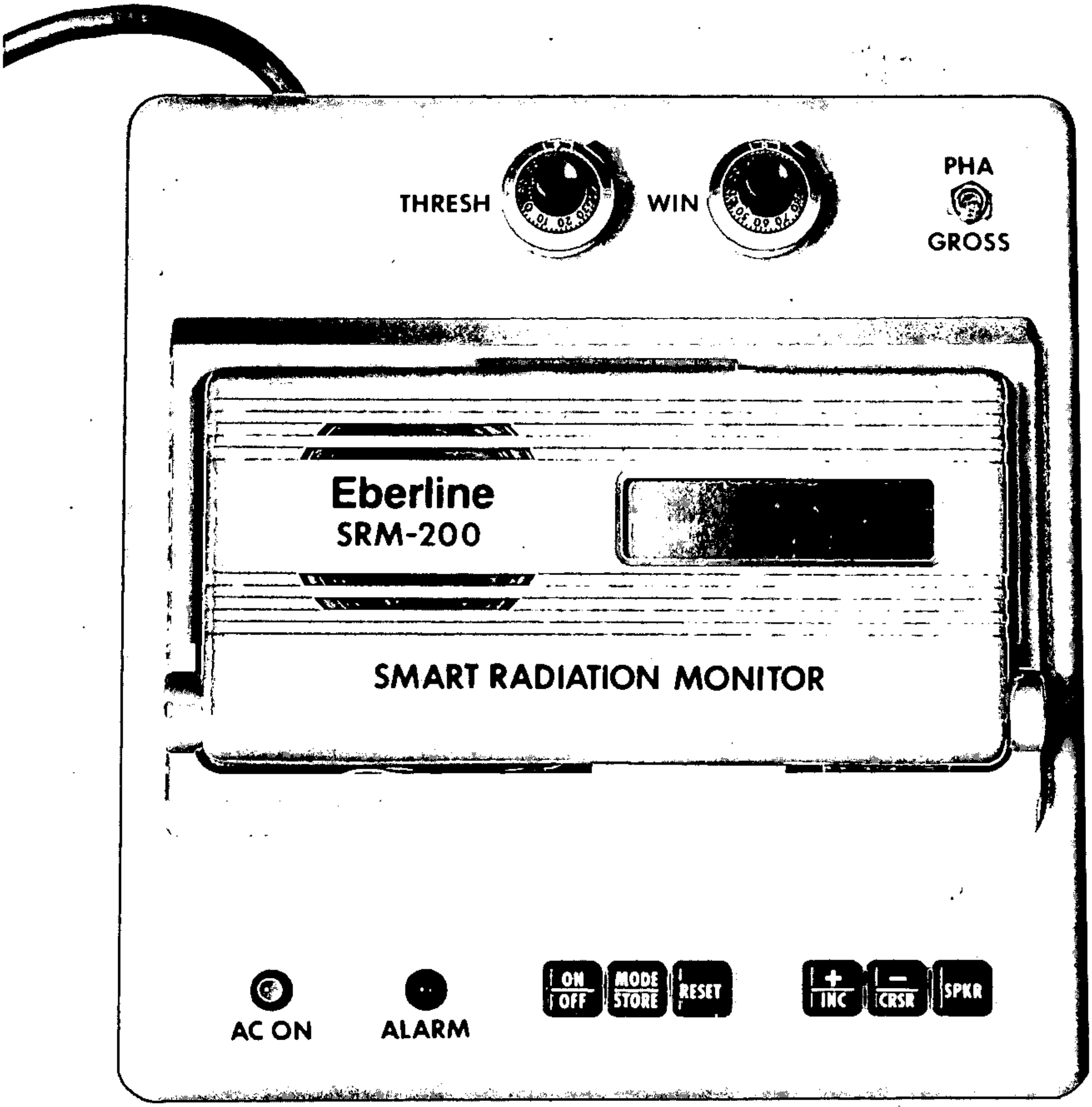


Figure 2-1, External Controls and Display.

e) In all utility modes (Log, Clock, Operate, Parameters): The RESET switch is used to initiate change of mode, time, number, or parameters. ""RESET" TO CHG." is displayed. "RESET WHEN DONE" is displayed in most cases where the item is being changed.

f) In the Parameters Mode: The RESET switch is pressed together with "+" or "-" switch to increase or decrease, respectively, values for alarm setting, calibration constant, dead time, high voltage, and count time.

4) +/INC: This is a multi-function switch. "+/INC" is used to answer yes to the question; "LOG THIS VALUE?" in modes where data is manually being stored. Use "+/INC" switch to increment the number over the cursor. When the Utility Mode Menu is displayed "+/INC" selects the Operate Mode. In the Utility Mode "+/INC" switch is used to answer yes to questions displayed and to step through the main menu items. "+/INC" is also used to select the slow time constant in the Ratemeter Mode.

5) -/CRSR: This is a multi-function switch. "-/CRSR" is used to answer no to the question "LOG THIS VALUE?" in modes where data is manually stored. The Utility Mode Menu will appear in this case. "-/CRSR" switch is used to move cursor to the next position left. At the extreme left position the next "-/CRSR" switch operation will move the cursor to the extreme right position. In the utility modes the "-/CRSR" is used to answer no to questions displayed and step through the main menu items in the reverse direction. When the Utility Mode Menu is displayed "-/CRSR" selects the Parameters Mode.

6) SPKR: Pressing the SPKR switch turns the speaker on or off. It also turns off the alarm when it sounds. If an alarm occurs, the speaker may be silenced by pressing SPKR.

7) PHA-GROSS switch: This external control is available with the optional PHA assembly installed. This switch is used to enable or disable the PHA function. In the GROSS position, all pulses above the threshold level are counted.

8) THRESHOLD potentiometer R27: This external control is available with the optional PHA assembly installed. This control sets the threshold level of the discriminator circuit. The gain of pulse amplifier may be adjusted so that ten turns of the dial will represent 25 millivolts (at the amplifier input) of threshold level.

9) WINDOW potentiometer R32: This external control is also available with the optional PHA assembly installed. This sets a "window" threshold relative to base threshold between which the pulse may be detected. If a pulse amplitude exceeds both thresholds the count is rejected. The pulse amplitude must be within the "window" to be accepted. If the gain of the amplifier is adjusted so that ten turns of the THRESHOLD control represents 25 millivolts as above, then one turn of the WINDOW control will represent 2.5 millivolts of input pulse amplitude.

b. Operator Controls - Internal (Figure 2-2)

Removing the bottom cover will provide access to the following:

1) R22, GAIN: This potentiometer adjusts the voltage gain of the detector pulse amplifier. It is usually set to the maximum cw position for maximum gain. When the PHA option is employed the gain may be lowered to increase the energy range of the window.

2) R27, THRESHOLD: This potentiometer is the threshold adjustment for the detector amplifier pulse height discrimination. It is set for an optimum input sensitivity for the detector being used. (See Section V, Table 5-1.) This potentiometer is replaced with a 10-turn externally mounted potentiometer when the PHA option is installed.

3) R68, HV LEVEL: This potentiometer is used in conjunction with R66, HV GAIN, to calibrate the high voltage. (See Section V.A.2.)

4) R66, HV GAIN: This potentiometer is used in conjunction with R68, HV LEVEL, to calibrate the high voltage.

5) S1-A, S1-B, S3-A, S3-B: The positions of these switches select the rate heard from the speaker. They are used to scale down the count rate from a high count rate detector (e.g.; SPA-3) to a more usable rate from the speaker. Available settings are: divide by 1, divide by 16, divide by 64, and divide by 256. When the switch lever is up the switch is off; down is on. Only one should be on at any one time. Figure 2-2 explains the switch settings.

6) S2-B: This switch is used with automatic testing only and should always be set in the operate position (lever down).

7) RESET: This is a pushbutton switch which when pressed with a battery lead disconnected will reset the computer and memory. (All stored calibration data will be lost.)

8) SPKR ON/OFF: this switch, located on the power supply assembly, is a slide switch which will activate the speaker when on, or deactivate the speaker when off.

9) LV ADJ: This potentiometer adjusts the DC output voltage of the DC power supply. This controls the voltage which trickle charges the battery.

10) LINE SELECT SWITCH: This slide switch selects which AC line voltage, 115 Vac or 230 Vac, is to power the SRM-200. Use care in selecting the line voltage or damage may occur to the instrument if the wrong line voltage is selected.

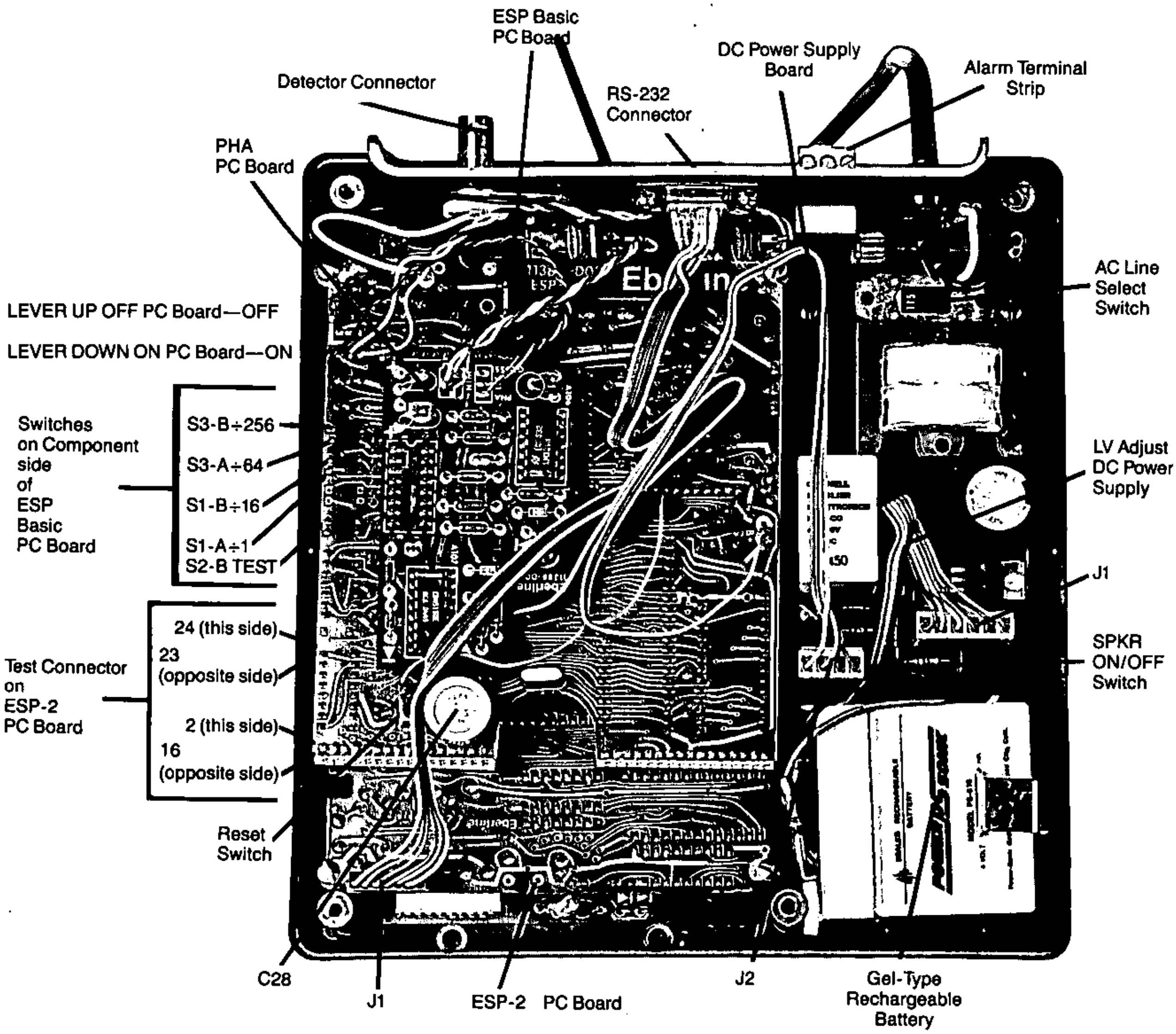


Figure 2-2, Internal Controls

B. PREPARATION FOR USE AND OPERATIONAL CHECK

Upon receiving the SRM-200 perform the following before proceeding:

1. Set Up the SRM-200 and Detector

The SRM-200 has an MHV connector on its rear surface for connection to a radiation detector. This connector supplies high voltage to the detector and also transmits the detector signal to the SRM-200 for processing and display. If the SRM-200 is already connected to a detector, then it is reasonable to assume that the high voltage has been previously set. If you are not sure that the high voltage has been properly adjusted, disconnect the detector from the instrument by rotating the cable connector counterclockwise. You can proceed through these instructions without the detector being connected.

CAUTION

> Failure to disconnect the detector from the instrument before turning it on can damage the detector if the high voltage is not set properly for the particular detector. Instructions for checking and setting the high voltage can be found in Section II.G.7.

When you are ready to connect the detector, verify that you have the proper cable. It should have a MHV connector on one end which mates to the SRM-200 and a connector on the other end to mate with the detector. Refer to your detector catalog sheet for the appropriate connector type. A MHV cable connector typically has white insulation in the center which extends slightly beyond the end of the metal portion of the connector. In contrast, a BNC cable connector typically has the insulation flush with the connector end. To connect the cable, rotate the connector clockwise.

2. Turn the instrument "On" or "Off"

Press the "On/Off" switch to turn the instrument "on". The same switch will have to be pressed to turn the instrument "off".

When the instrument is turned on, the display will depend on the selected mode. If the selected mode is Ratemeter, the display should indicate a numerical value on the lower line and a bar graph on the upper line. The bar graph may be off-scale, so press the RESET button to get it back on scale. Refer to Section II.C. for more information on the displayed information. Refer to Section II.D. for the appropriate display if the unit is in one of the scaler modes.

If the instrument has been properly calibrated and is connected to a detector, it is ready to use. Refer to Section II.G. for instructions on how to view and change the calibration parameters.

A quick check to determine that the instrument is functioning is to compare the numerical value being displayed to the background radiation level. If they are close then the instrument is operating and ready to use. Remember that normal statistical fluctuations can cause relatively large changes in the displayed reading at low levels. Press the SPKR button and you should hear a click corresponding to each detector event. If this is not the case, the speaker rate switch could be in wrong position. Refer to Section II.A.6.

3. **Determine Battery Level**

Examine the first character space in the display (upper left hand corner). If it is blinking, the battery is discharged and needs recharging. The SRM-200 uses a 6V Gel-cell battery.

The instrument automatically turns itself off 1 hour after the low battery condition signal is given. The SRM-200 can be turned back on after it turns off, but will turn itself off again after 1 hour.

4. **Example Setup**

The following procedure is given as an example to setup an HP-270 detector for use with the SRM-200: (These functions may be setup from the Parameters Mode.)

a. Select detector 1 file and assign it the name of "HP-270".

b. Set the high voltage to 900V as shown on the detector's Calibration Certificate. (The nominal value is 900V given in Table 5-1.)

c. Set the units to display "mR/h".

d. Set the calibration constant to be 7.30 + 07 as shown on the detector's Calibration Certificate. (The nominal value is 7.20 + 07 given in Table 5-1.)

e. Set the dead time to 1.10 - 04 as shown on the detector's Calibration Certificate. (The nominal value is 1.00 - 04 given in Table 5-1.)

f. Set the alarm to the desired value.

g. Select the Normal Ratemeter Mode.

h. Exit the Parameters Mode and connect the HP-270 detector to the instrument. It is ready for use.

C. OPERATION IN THE RATEMETER MODE

The Ratemeter Mode has two sub modes - Normal Ratemeter Mode and Peak Trap Ratemeter Mode. The instrument acts as a "normal" ratemeter in the first mode. For example, the display will output a bar graph whose length is proportional to the number of detector events per unit time and a numerical reading whose value is expressed in the measurement units selected by the user. The current ratemeter reading may be logged by pressing the STORE key.

In contrast, the Peak Trap Ratemeter Mode works just like the Normal Ratemeter Mode except that the peak ratemeter reading that has occurred since the last pressing of either the STORE key or RESET key is held in an internal memory buffer. When the STORE key is pressed, the peak value is logged instead of the current reading.

1. **Analog Bar Graph (at the top of the display)**

The length of the analog bar graph is proportional to the detector count rate. One purpose of the bar graph is to permit more rapid recognition of a sudden increase or decrease in the radiation field being measured than can be achieved using the digital display.

If the bar graph is off scale in either direction, it may be brought back on scale by pressing the RESET key. The full scale value of the bar depends on the level of radiation being measured. Pressing the RESET key always resets the length of the bar graph to a point that is 33 percent of full scale. If the bar graph is displayed and is varying, the SRM-200 is working.

2. **Numerical Value of Count Rate (at the bottom of the display)**

The second line of the display is the numerical value of the count rate. The value may be expressed in one of two ways. The first way is scientific notation which is a three digit number followed by a second positive or negative number. The second number corresponds to a power of 10. Example: 1.00 + 02 mR/h is 1 x 10^2 = 100 mR/h. The second way the numerical value may be expressed is by a three digit floating point number followed by the units (e.g. µR/h, mR/h, R/h, kR/h). The prefix to the units changes automatically to express the decade the value is in. The decimal point of the integer will float (e.g., .xxx, x.xx, xx.x, xxx) to allow three decades of range for one prefix setting. Thus, the auto-prefix mode will allow twelve decades of range. Above or below this twelve decade range, scientific notation is employed to express the values. The SRM-200 has one decade of hysteresis built in at each prefix change to prevent oscillation in the units display. When the prefix does change, it is flashed for a few seconds to alert the user to the change. The auto-prefix feature is selected in the Parameters Mode while specifying units.

3. **Accuracy, Precision and Response Time**

Accuracy of the SRM-200 reading depends upon a number of factors, the most important being the calibration procedures utilized. Also critical are the data manipulation techniques employed by the SRM-200 to convert the pulse rate from the detector to the reading output to its display.

There is a direct trade-off in pulse counting instruments between response time and the statistical standard deviation (precision) in the reading. The SRM-200 utilizes a self-adjusting response time to maintain a fixed statistical standard deviation in the value measured. Response time is defined as the time required to reach 90 percent of the final value of the step size due to a step change in the input.

Response time is adjusted automatically by the microcomputer in the SRM-200 using a weighted average algorithm with variable weighting parameters to maintain a fixed statistical precision over a wide range of detector pulse rates. Two fixed precision levels are available depending upon whether the fast or slow response time range is desired. The selected nominal precision level is maintained over the range of count rates from approximately 50 to 500 cpm. Below and above these count rates the statistical precision is poorer and better respectively. The Normal Operating Mode provides a reading that has a nominal standard deviation of 5 percent within response time constraints of one and ten seconds. This is referred to as the fast response time mode. When the "+" key on the SRM-200 is depressed (and for one minute following its release), the reading displayed has a standard deviation associated with it of nominally 3 percent within response time constraints of one and thirty seconds. The 3 percent mode is always used whenever the SRM-200 is in the menu (Parameters) mode. This is referred to as the slow response time mode.

The SRM-200 reading is calculated every 0.5 seconds and an alarm check is made at that time as well. The SRM-200 minimum response time is fixed at one second and the display is updated every two seconds.

4. Alarm

The alarm point is a selected value which results in an audible alarm when the counting rate reaches that value. To silence the alarm, press SPKR key. The alarm will sound even if the speaker is off at the time the alarm is activated.

The alarm point can be viewed and changed provided the instrument is set for at least access level 1. See Section II.G.4. on how to view and or change the alarm setting.

5. Over Range Indication

When the detector pulse rate exceeds the capability of the SRM-200 to maintain a linear relationship between radiation level and the displayed reading, the words "OVER RANGE" will appear on the display in place of the analog bar graph. The numerical value will still be displayed but SHOULD NOT BE RELIED UPON as the useful range of the SRM-200 and detector has been exceeded. This is a latching condition and once it occurs the words "OVER RANGE" will be displayed. To clear the condition, the SRM-200 must be turned off and then back on. The over range determination is based upon the detector pulse rate and the dead time (see Section II.G.6.). This feature REQUIRES that the SRM-200 and detector be properly calibrated for it to function correctly.

6. Storing Readings in Ratemeter Mode

To store or log a particular ratemeter reading while using the default "STORE" function press the STORE key. The following will appear on the display:

LOG THIS VALUE?
(ratemeter reading)

Press "+" to answer yes and the following display will appear:

LOC. CODE xxxxxx
(ratemeter reading)

The location code may be edited now. Pressing "+/INC" will increment the numbers above the cursor and pressing "-/CRSR" will shift the cursor. The six digit location code number will automatically increment one unit every time the STORE key is pressed. This feature aids in logging data at sequentially numbered locations.

Press "STORE" again and the measurement value is "stored" and the instrument returns to its normal operating mode. Data is stored in this manner in both the Normal Ratemeter Mode and in the Peak Trap Ratemeter Mode.

To store or log a particular ratemeter reading with the Enhanced Store features enabled and Auto-store selected, press the STORE key. The following display appears:

LOC. CODE xxxxxx
x.xx ± xx (rate units)

The top line has the location code for the data to be stored. Press any key (except "RESET" or "LIGHT") before the user selected pause of 1 to 5 seconds expires and the number can be edited and then stored by pressing the STORE key again. Otherwise, a display pertaining to the selection of a detector may appear (if auto detector select has been enabled) such as:

#x
(AUTO SELECTING)

The top line is the detector number and identification string, whose calibration parameters will be loaded and used for taking the next measurement with the detector which is already connected to the instrument unless a key is pressed before the pause time expires. After this display the instrument automatically reverts to the normal ratemeter mode display. Observe that only one key stroke was used to store data in this configuration.

7. Operating in the Peak Trap Ratemeter Mode

This mode may be selected from the Parameters Mode (see Section II.G.2.). Operation in the Peak Trap Ratemeter Mode is the same as in the Normal Ratemeter Mode, except that the peak ratemeter reading that has occurred since the last pressing of the STORE or RESET key is stored in a memory buffer. It is this peak value that is displayed when the STORE key is pressed. The store operation is not complete until the STORE key is pressed again after the location code is displayed. Normal ratemeter reading (not peak reading) is displayed while measurements are being made in this mode. This mode is useful for locating "hot" spots in an area survey.

D. OPERATION IN SCALER MODE

There are three different Scaler Modes in which the instrument may operate. They are Average Rate, Integrating, and Fixed Precision. In the Average Rate Scaler Mode, the detector events are integrated for a preset time selected by the user and the average rate is displayed. The average rate is displayed continually during the scaler interval and is updated as time progresses with the most accurate reading occurring at the end of the preset period. In the Integrating Scaler Mode, readings are integrated for the preset time selected by the user. The integrated reading in user selected units is displayed at the end of the scaler interval. In the Fixed Precision Scaler Mode, the measurements are integrated for a computed interval as required to generate the selected "fixed" precision of the reading. The reading is displayed in rate units. Thus the low count signals are integrated for a longer period of time than are higher count rates in order to produce the required precision. The interval automatically adjusts between the limits of 1 second and 4 hours.

These Scaler Modes may be selected in the Parameters Mode (see Section II.G.2.).

1. Average Rate Scaler Mode

While operating in this mode, the detector events are integrated for a preset time selected by the user. The integrated events are then divided by the expired time to produce average rate. The average rate is continually displayed during the preset interval. Thus the last value displayed in the interval is the most accurate.

If the Average Rate Scaler Mode has been selected, turning the instrument on will produce the following display:

```
CNT FOR 0:01:00
RESET TO START
```

One minute is the default time, i.e., the time the computer selects for scaler preset time unless a different time has been input from the keypad. Pressing RESET starts the count and the following display appears:

```
0:00:xx LEFT
x.xx (rate units)
```

The measured rate, averaged over the time from when the RESET key was pushed, is displayed on the second line. The first line represents the time remaining in the count interval. To change the count time from the default one minute, enter the Parameters Mode (assuming your instrument is set for access level 1 or greater) and step through the Parameters Mode menu using the "+" or "-" key until you get to the following display:

```
CNT FOR 0:01:00
SCALER MODE
```

Press RESET and "+" to increase the time or press RESET and "-" to decrease the time. To exit the Parameter Mode press MODE key and you will be back in the Scaler Average Rate Operating Mode.

While selecting any Scaler Mode, including Average Rate Scaler Mode, you have the option of selecting auto-recycle or manual. Auto-recycle will automatically, at the end of the preset scaler interval, store the average rate and reset the Scaler Mode so that a new time interval is begun. If manual was selected, then at the end of the preset time interval, the integration would stop and wait. To store the average rate you would press STORE key, press "+" to answer yes, edit the location code, and press STORE key again. Then to start a new cycle you would press RESET key.

If Auto-Recycle Mode had been selected, then the measurement is automatically stored at the end of the preset interval. If not, then the speaker will beep at the expiration of the preset interval and the following display will appear:

CNT FOR x:xx:xx
x.xx ± xx (units)

Press STORE and the following display appears:

LOG THIS VALUE?
x.xx + xx (rate units)

Press "+" and the following display will appear:

LOC. CODE xxxxxx
x.xx + xx (rate units)

Press "+/INC" to change the location number above the cursor and press "-/CRSR" to shift the cursor position. After editing the location code press STORE to store the value and to return to the initial operating display. Note that if Auto-Recycle Mode had been selected then the location code is not automatically incremented.

2. **Integrating Scaler Mode**

The main difference between this mode and the Average Rate Scaler Mode is that the integrated count is displayed instead of the average rate.

If the Integrating Scaler Mode has been selected, turning the instrument on will produce the following display:

CNT FOR 0:01:00
"RESET" TO START

One minute is the default time and it may be changed. Press RESET key and the scaler count begins. This display will appear:

x:xx:xx LEFT
x.xx (units)

The first line shows the time left for the scaler count and the second line shows the count in selected units. If auto-recycle and auto-log were selected, then when the count time expires, the time left would automatically be reset and the scaler count automatically stored in memory and automatically logged to an external device. If the manual recycle was selected, then when the count time expires, the speaker beeps, and the following display appears:

CNT FOR x:xx:xx
x.xx ± xx (units)

Press STORE to log the value and the next display is:

LOG THIS VALUE?
x.xx+/-xx (units)

Press "+" and the following display appears:

LOC. CODE xxxxxx
x.xx + xx (units)

Edit the location code, if desired, and press STORE to log the count. RESET key then must be pressed to begin a new scaler count.

3. **Fixed Precision Scaler Mode**

The user may select a certain precision (2, 5, 8, or 10 percent at the two sigma confidence level) for the rate measure he wants to make. The computer automatically computes the time interval required for the selected precision. The greater the precision the greater the interval required. The computed time interval ranges from 1 second to 4 hours.

This mode is selected in the same manner as the Average Rate Scaler Mode. Get to the mode select menu in the Parameters Mode and press RESET to change. The following display will appear:

SCALER MODE?
+ = USE/ - = NO

Press "+" and the following will appear:

FIXED PRECISION
+ = USE/ - = NO

Press "+" and the following will appear:

PRECISION xx%
+ = USE/ - = NO

Press "-" until the desired precision is displayed. The choices are 2, 5, 8, and 10 percent. Suppose we want 10 percent, so we press "-" until 10 percent appears in the upper right hand corner of the display. Then press "+" to use it. The next displays prompt whether we want auto-recycle, auto-log, etc. After making those selections we press "MODE" to exit the Parameters Mode and return to the Fixed Precision Operating Mode. The display of time left in this operating mode is computed based on how fast the counts are arriving. The faster the counts, the shorter the time left. The default time left is 4 hours (for low count rates).

If you have not selected auto-recycle, the display will appear as follows:

PRECISION 10%
"RESET" TO START

Press RESET; the measurement starts and the following appears:

x:xx:xx LEFT
x.xx (rate units)

At the end of the measurement cycle the speaker beeps and this display appears:

PRECISION xx%
x.xx + xx (Rate Units)

Press store and then you will be given the opportunity to log the value. (See Section II.D.1. and 2. above for the description of how to store measurements.) Then you can begin a new cycle.

4. Storing Data in a Scaler Mode

During the selection of a Scaler Mode from the Parameters Mode, you are given the option of selecting auto-recycle or manual-recycle. Auto-recycle will automatically, at the end of the preset scaler interval, store the reading and reset the Scaler Mode so that a new measurement interval is begun. If manual-recycle were selected, then at the end of the measurement interval, the integration would stop and wait. A display showing the resulting integrated value is displayed. Press STORE key to cause the display to ask if you want to log this value. Press "+" to answer yes, edit the location code if desired, and press STORE key again. Then to start a new cycle you would press RESET key.

If you had selected auto-recycle, the data is automatically stored at the end of the measurement interval. Also, if auto-log had been selected, then the freshly stored data would be output to a printer or peripheral device connected to the instrument.

Another SRM-200 store feature that is available for operation in all scaler modes is the Enhanced Store function. This feature provides the capability for the instrument to automatically switch between any of the three allowed sets of the detector calibration parameters between "Store" operations. Also available with Enhanced Store function is one key store operation. See Figures III.18, 19. The Enhanced Store functions are selected from the Operate Mode menu. See Section II.E.3.

E. USING THE OPERATE MODE

1. Entering the Operate Mode

This mode may be entered from any operating mode (Ratemeter or Scaler Modes). Press MODE key and the following display appears:

LOG THIS VALUE?
(reading, units)

Press "-" key to answer no and the following display appears:

R/COMM -/PARAMS
+/OPER S/CLOCK

Press "+" key to enter the Operate Mode.

2. System Level Parameters

On entering the Operate Mode the first display that appears is:

ACCESS LEVEL x
"RESET" TO CHG.

This display appears at all access levels, 0 through 4. The access level may be changed here. Press RESET to change access level. This display will appear:

KEY xxxxx
"RESET" WHEN DONE

The first four digits of the KEY number are the instrument I.D. number's four lower digits. The access level, 0 through 4, is the last digit. Press the "+" key to change the digit above the cursor. Press CRSR to shift the cursor. The instrument I.D. number must be known if the access level is to be changed. The instrument I.D. number is the code which provides operational security and permits changing access level. Therefore, it must be "controlled" if access level security is to be maintained.

When power is first applied to an instrument, as when the batteries are installed for the first time, and the instrument is turned on, the instrument I.D. number will be zero, and the access level will be 4. At access level 4, the instrument I.D. number may be entered by the person controlling security and then the access level set as desired.

Once the instrument I.D. number has been entered into the instrument it must be entered as part of the KEY number in order to change the access level.

Press "+" or "-" to step through the menu in the Operate Mode. Press "+" and the following will appear on the display:

I.D # xxxxxxxxx
"RESET" TO CHG.

This first line is the user I.D. number. It may just be viewed or it may be changed. Press RESET and the following display will appear.

I.D. # xxxxxxxxx
"RESET" WHEN DONE

The user I.D. number is changed using the "CRSR" key to select the digit and the "+" key to change it. Press RESET and then MODE to exit the Operate Mode.

To change the instrument number, enter the Operate Mode and step through the menu until the following display appears:

INSTR. # xxxxxx
"RESET" TO CHG.

Press RESET and observe the following:

INSTR. # xxxxxx
"RESET" WHEN DONE

Enter the instrument number using the "CRSR" key to select the digit and the "+" key to change it and press RESET.

Also available in the Operate Mode and at Access Level 4 is the capability to switch between Default Store and the Enhanced Store functions. One of these functions is in effect while making and storing measurements in all operating modes. Default Store, when selected, enables the normal or "default" functions described throughout this manual. Enhanced Store provides additional capabilities such as storing by pressing only one key and selection of up to three sets of detector parameters for extra measurement capabilities. Press "+" and the following display appears:

DEFAULT "STORE"
"RESET" TO CHG.

Press RESET and the following display appears:

ENHANCED "STORE"
"RESET" TO CHG.

The Enhanced Store function is now selected. Press "+" to select the next menu item under Enhanced Store function. The next display is:

AUTO INC. LOC.
"RESET" TO CHG.

If "+" were pressed, then anytime the store key is pressed, the location code is automatically incremented. However, press RESET to see what the alternate option is:

MANUAL INC. LOC.
"RESET" TO CHG.

This option is useful where one needs to make several measurements at a single location. Press "+" and the next menu item under Enhanced Store appears:

AUTO "STORE"
"RESET" TO CHG.

If this menu item were selected, then one key storing the data would be available. Press "+" and the next display is:

AUTO PAUSE x
"RESET" TO CHG.

Pressing RESET selects values of pause time from 1 second to 5 seconds. If, from the auto "Store" menu, "RESET" had been pressed instead of "+" the following display would appear:

MANUAL "STORE"
"RESET" TO CHG.

This option allows storing to be done in the usual way with a series of keystrokes. Press "+" and the last set of options in Enhanced Store function appears. There are four of these as shown below and may be stepped between with the RESET key:

DET. SELECT OFF
"RESET" TO CHG.

If this one were selected, there would be no automatic capability to switch detector parameters while making measurements. Press RESET and the next option appears:

MANUAL DET. SEL.
"RESET" TO CHG.

This option directs the menu to the regular detection selection menu found in the Parameters Mode. So one may manually change detector parameters and/or change the actual detector. Press RESET to see another option:

2 DET. AUTO SEL.
"RESET" TO CHG.

With this one selected, the instrument automatically switches between two sets of detector calibration parameters, permitting one to make more than one type of measurement with a single detector. The SRM-200 always tags both data points with the same location code. The final options is:

3 DET. AUTO SEL.
"RESET" TO CHG.

Press MODE key to exit the Operate Mode.

IMPORTANT

> When making measurements with Enhanced Store function enabled, pressing MODE key for the scaler modes or pressing MODE and RESET together for the Ratemeter Mode will cause the Utility Mode Menu to be displayed.

F. USING THE CLOCK MODE

Enter the Utility Mode Menu in the display by pressing MODE and "-" key. From the Utility Mode Menu press SPKR to select the Clock Mode. If the access level is 3 or greater you may read and set the clock. Observe the following display:

JUN 15, 86 1230
"RESET" TO CHG.

JUN 15, 86 1230 is the default time. The hour of day is presented in military time, that is, 0000 through 2359 hours. Press RESET to set the clock to current time. Observe the following display:

JUN 15, 86 12xx
"RESET" WHEN DONE

Using "+" to increment the digit above the cursor and CRSR to move the cursor to select digits, set the current date and time. Press RESET and revert back to the initial clock display except the current date and time is now displayed. Press MODE to exit the Clock Mode.

G. USING THE PARAMETERS MODE

From this mode you may select one of three detectors, change the detector I.D., change the operating mode or sub mode, change the mode parameters, such as count time, and alarm setting, or you may change the detector calibration parameters such as units, calibration constant, dead time, and high voltage.

The count time and alarm setting may be changed at access level 1 or greater. Detector selection may be made at access level 2 or greater, the mode at 3 or greater, and the units, calibration constant, dead time and high voltage may be changed at access level 4.

1. Selecting Detectors

You may select from three sets of preprogrammed detector parameters stored in the computer memory. When you select a detector, you are in fact automatically setting the high voltage, the calibration constant, the dead time, the alarm, preset time, etc., necessary for the instrument to operate with that detector.

Enter the Parameters Mode and the first menu item to appear is detector selection:

#1 (DET. NAME)
"RESET" TO CHG DET

Press RESET and the following display appears:

USE DET. #1?
#1

Press "-" and you can step through your choice of three detectors, 1, 2, or 3. When you get to the one you want to use press "+" to answer yes and then you will be given the opportunity to edit the detector information:

EDIT DET. INFO?
#1

Press "+" and the following display will appear:

"RESET" WHEN DONE
#1_

The cursor appears in the display. Press "+" to step through the alpha-numeric characters available plus "-", ".", "/". When the desired character appears, release "+" and press CRSR to shift the cursor to the next character and so on. You can insert up to 13 characters. A typical detector I.D. is "HP-270". Press RESET when completed. Until this particular selected detector is changed again all detector parameter changes such as high voltage, calibration constant, etc. will be "tied" to that detector number and I.D. Press MODE to exit the Parameters Mode.

2. Selecting Operating Modes

Figure 3-14 shows the functional flow diagram for selecting the operating mode and it shows the various operating modes the instrument functions in.

The two most basic modes are Ratemeter and Scaler. The Ratemeter Mode has two operating modes: Normal Ratemeter Mode and Peak Trap Ratemeter Mode. The Scaler Mode has three operating modes: Average Rate Mode, Integrating Mode, Fixed Precision Mode. Coupled with each of the Scaler Modes are the sub modes of auto-recycle, auto-log, manual reset, manual store, and manual log output.

You are permitted to change modes in the Parameters Mode only if the instrument is set for access level 3 or 4. For purposes of this discussion we will assume the access level is at 3.

From any of the operating modes, press the MODE key and the following display will appear:

LOG THIS VALUE?
(reading, units)

Press "-" to answer no and we get the Utility Mode Menu.

R/LOG -/PARAMS
+/OPER S/CLOCK

Press "-" to select the Parameters Mode. The first display to appear in Parameters Mode has to do with selecting detectors. Press "+" to step through the Parameters Mode items the next one being:

(current operating mode)
"RESET" TO CHG.

This display will be any one of those in Figure 3-16. For purposes of illustration, assume we have been operating in the Normal Ratemeter Mode and we wish to change to the Integrating Scaler Mode. The above display would appear thus:

RATEMETER MODE
"RESET" TO CHG.

Press RESET key and the following display appears:

SCALER MODE?
+ = USE/ - = NO

Press "+" key and the following display appears:

FIXED PRECISION
+ = USE/ - = NO

Press "-" and the following displays appears:

INTEGRATING
+ = USE/ - = NO

Press "+" and the following display appears:

AUTO RECYCLE
+ = USE/ - = NO

We have the choice of selecting the Auto-Recycle Mode. This mode will automatically store the reading at the end of preset scaler interval and will automatically start a new interval. The Scaler Mode will keep recycling. However, the location code associated with the measurement being stored is not incremented. If we press "-" here we will have selected the Manual Store Mode. Press "+" and the following display will appear:

AUTO LOG?
+ = USE/ - = NO

This display gives us the option of using the Auto-Log Mode when we are operating in the Integrating Scaler Mode. the Auto-Log Mode will work in addition with the Auto-Recycle Mode to automatically output the stored data to a peripheral device. The data is output immediately each time after it is stored. If we don't select the Auto-Log Mode and if we want to output the data, we will have to enter the Log Mode. Press "+" and the following display appears:

SCALER MODE
"RESET TO CHG"
INTEGRATING
AUTO RECYCLE/LOG

Since we have a two line display, the second, third, and fourth lines are displayed alternately. The instrument has been set for the Integrating Scaler Mode and to exit the Parameters Mode to start operating in the Integrating Scaler Mode, press MODE key.

You have successfully changed the operating mode of the instrument. To have changed to the Peak Trap Ratemeter Mode, you must follow the same procedure as above until you get to the display which asks you if you want to use this Mode. Press "+" key to answer yes. Answer the following questions in the displays with a "+" for yes and a "-" for no. After the desired mode has been identified press MODE and enter the selected operating mode.

3. Changing Units

The measurement units may be changed at access level 4. Enter the Parameters Mode as described above and step through the Parameters Mode menu items until you reach the following display:

UNITS = (units)
"RESET" TO CHG.

The current measurement units are displayed in the upper line. Cnt/s are the default units. Press RESET and observe the next display:

BASE cnt
+ = USE/- = NO

The selection of the BASE units is now possible. The choices available for base radiation units are:

R	Roentgen
cnt	counts
Gy	Gray
Sv	Sieverts
REM	roentgen equivalent man
dis	disintegrations
rad	radiation absorbed dose

Notice that only the base unit is displayed; thus, if mR/h is desired on the display, select "R" as the base unit. The prefix (milli) and the suffix (h) will be added in the next steps.

Press "-" to reject the displayed base unit, and another selection will be offered. When the display shows the desired base unit, press "+" to accept it.

CAUTION

> Selection of a new base unit requires an appropriate change in there calibration constant (CC). Refer to Section II.G.5. Changing the prefix or suffix DOES NOT affect calibration and so requires no change in the calibration constant.

Selection of Suffix:

After the "+" is pressed above to accept the base unit, the display will then present the selection of SUFFIX as follows:

SUFFIX /s
+ = USE/- = NO

The suffix is the unit of time used to calculate the displayed ratemeter reading. Three are available:

s	second
min	minute
h	hour

Again, press the "-" switch to reject the suffix displayed and another selection will be offered. When the desired suffix is displayed, press "+" to accept it.

Selection of Prefix:

After the "+" is pressed above to accept the suffix, the display will then present a prefix which may be added to the base unit to get a more convenient unit of actual measurement.

PREFIX (value)
+ = USE/- = NO

The prefix is the value by which the base unit is scaled to provide a more convenient unit of measurement. Five are available:

(NONE)	no prefix
μ	micro (x 10^{-6})
m	milli (x 10^{-3})
K	kilo (x 10^{+3})
AUTO	automatic calculation and display of a prefix and a 3 digit numerical value

If the prefix displayed is not the desired value, then press "-" to reject it and view the next choice. When the desired prefix is displayed, press "+" to select it. The setting of radiation units to be measured would now be complete. An example of this would be:

PREFIX	BASE		SUFFIX
m	R	/	h
(milli)	(Roentgen)	/	(hour)

The units may be selected in any combination of prefix/base/suffix. Press the "+" switch to select the prefix. Exit the Parameters Mode by pressing MODE.

4. Changing Alarm Setting

The alarm setting may be changed at access level 1 or greater in the Parameters Mode. The value of the alarm setting is expressed in units that are set for the current operating mode. For example, if the current operating mode is ratemeter and the ratemeter units are cnt/s, then the alarm setting units are cnt/s. If the current operating mode is Integrating Scaler Mode and the selected units are mR, then the alarm setting will be in units of mR. Even through the second line will contain rate units (e.g. mR/h), when the alarm setting is displayed, the alarm setting has integration units (e.g. mR).

Enter the Parameters Mode and step through the menu by repeatedly pressing the "+" key until the following display appears:

ALM AT x.xx+xx
(rate reading, units)

To change the alarm value, press RESET key and "+" key simultaneously to increase the value or press RESET key and "-" key simultaneously to decrease the value.

NOTE

> When pressing RESET and "+" or RESET and "-" simultaneously to change a parameter, always press the RESET key before "+" or "-". If the computer senses the user pressing "+" or "-" first, it may interpret the entry as a command to display the next menu item.

After the desired value is displayed press MODE key to exit the Parameters Mode. Remember that this alarm value is set for the selected detector and will be stored in memory if another detector is selected. Thus, up to three different alarm values, for three different detectors, are held in memory.

The alarm can be disabled by setting it to an extraordinary high value.

5. Setting the Calibration Constant (CC)

a. Definition of Calibration Constant:

The calibration constant (CC) is the number used to convert the counts from the detector to the previously selected base unit. Specifically, the displayed ratemeter reading is derived by dividing the counts per seconds (from the detector) by CC and then scaling the result based on the selected prefix and suffix.

b. Display of Calibration Constant (CC):

Enter the Parameters Mode and step through the menu until the following is displayed:

CC = (numerical value)
(ratemeter reading)

c. Selection of Calibration Constant (CC) for Detectors Which Were Purchased with the SRM-200 from the Factory:

If a detector was purchased with the SRM-200 from the factory, the calibration constant will already be set at the factory for this detector, and the following section may be bypassed until a different type of detector is to be used with the instrument or until time for routine re-calibration of the instrument.

The calibration constant will have to be changed when switching detectors. If the detector is one which has a preset parameter stored in the SRM-200, this can be performed by selecting the detector from the three preset detectors (refer to in Section II.G.1). When changing one detector to another either use the detector parameters stored in the SRM-200 or enter a new calibration constant by using the calibration constant which is given on the calibration sheet supplied with the SRM-200.

d. Selection of Calibration Constant for Various Detectors:

1) If the detector was not purchased with the SRM-200 and, thus, a calibration sheet is not available, use the nominal value for the particular Eberline detector which is given in Table 5-1.

2) The display for changing the CC is produced from the Parameters Mode and appears as follows:

CC = (numerical value)
(ratemeter reading)

To increase the value of CC, press RESET and "+" simultaneously. To decrease the value of CC, press RESET and "-" simultaneously.

3) To calculate a calibration constant for detectors other than those listed in the table, the sensitivity of the detector must be known and is usually found in the list of specifications given on the catalog sheet. Calculation using a HP-270 detector as an example is given as follows:

EXAMPLE (HP-270 detector):

Sensitivity = 1200 cnt/min/mR/h

$$CC = 1200 \frac{cnt/min}{mR/h} \times 1000 \frac{mR}{R} \times 60 \frac{min}{h}$$

$$= 7.2 \times 10^7 \text{ cnt/R}$$

6. Setting the Dead Time (DT)

a. Definition:

The dead time correction constant is a derived number used to correct for counting losses due to inability of the detector to recover at high counting rates. This correction results in a more linear response to the radiation field being measured and extends the useful range of some detectors used with the SRM-200 by as much as a factor of ten (which provides the equivalent of an extra range on a standard ratemeter).

b. Selection of DT for Detectors Which Were Purchased from the Factory with the Instrument:

If the SRM-200 was purchased with a detector(s) from the factory, the DT value(s) will be correctly set at the factory and the next section may be bypassed until it is necessary to use a different detector or until time for routine calibration.

When changing from one detector to a detector purchased with the SRM-200, use the DT stored with the other parameters for that particular detector or the DT given on the calibration sheet supplied with the combined SRM-200 and detector.

c. Selection of DT for Various Detectors:

1) If the detector was not purchased with the SRM-200 and, thus, a combined calibration data sheet is not available, use the nominal value for the particular detector which is given in Table 5-1.

2) To change the value of DT, enter the Parameters Mode and step through the menu until the following display appears:

DT (SEC) x.xx-xx
(ratemeter reading)

To increase the value of DT, simultaneously press "RESET" and "+". To decrease the value of DT, simultaneously press "RESET" and "-".

3) For a detailed discussion of DT consult Section V, MAINTENANCE, A. Calibration, Table 5-1.

CAUTION

If you do change detectors, the calibration constant (CC), the dead time (DT) and the high voltage must be changed. Use the procedures described in Section II.G., steps 5, 6, and 7.

4) Press MODE to exit the Parameters Mode.

7. Setting the High Voltage for the Detector of Choice

a. Selection of High Voltage for Detectors which were Purchased from the Factory with the Instrument:

If a detector was purchased from the factory with the instrument, the operating high voltage will already be set at the factory for this detector, and the following section may be bypassed until a different type of detector is to be used with the instrument.

b. Selection of High Voltage for Various Detectors:

1) If the calibration data sheet supplied with the detector is available, use the recommended operating high voltage which is given there.

2) If the calibration sheet supplied with the detector is not available, use the following general recommendations:

a) Geiger-Mueller (GM) type detectors (HP-190, HP-260, HP-270): use 900 volts (exception: HP-290 requires 500 volts).

b) Scintillation detectors: You must determine the plateau response of the detector according to the procedure described in Section V.A.3. and Figure 5-1, and select as the operating voltage a value which is 50 volts above the beginning of the plateau.

c. Procedure for Determining the Present Setting for the High Voltage as Viewed on the Display.

Enter the Parameters Mode and step through the menu until the display below appears. The display shows the present value for the high voltage setting and looks like this:

HV = (numerical value)
(ratemeter reading)

If this value is not the recommended high voltage for the detector which you plan to use with the instrument, change the value using the directions given in the next step d).

d. Changing the High Voltage:

1) Disconnect the detector from the instrument by rotating the MHV connector on the cable to the detector counterclockwise.

2) Use the Parameters Mode to change the high voltage. Press MODE and this display will appear:

LOG THIS VALUE?
x.xx cnt/s

Press "-" to answer no and observe the utility modes selection menu:

R/COMM -/PARAMS
+/OPER S/CLOCK

Press "-" and enter the Parameters Mode. The menu of items in the Parameters Mode may now be viewed by pressing either "+" or "-" and stepping through them. Assuming the instrument has been set for access level 4, repeatedly press "+" until the following display appears:

HV = 5.00 + 02
x.xx (units)

The high voltage default value is 500 Vdc. It is adjustable from 500 Vdc to 2450 Vdc. Disconnect the detector prior to changing the HV. Press RESET and "+" simultaneously and observe the high voltage setting increase. The value increases more rapidly the longer you press these two keys. Press RESET and "-" to decrease the high voltage. When the desired value of HV is displayed, exit the Parameters Mode by pressing the MODE key.

CAUTION

The operating high voltage must be changed when switching to a different type of detector, such as switching from a Geiger-Mueller (GM) type of detector (HP-210, HP-260, HP-190, HP-270) to a scintillation type detector (LEG-1, SPA-3, SPA-6, etc.), or to GM detector requiring a different high voltage (HP-290), or to a proportional detector such as the neutron detector (NRD-1).

Make sure that you have changed the high voltage to the correct setting when changing between detectors BEFORE you attach the detector to the SRM-200. This will protect your detectors from accidental exposure to voltage which is too high for the detector. While using the detector selection features of SRM-200, make sure you disconnect the detector before you select another detector from the keypad. Make sure the detector type you select matches the detector you are about to connect.

3) The detector of choice may now be attached to the SRM-200 since there is now assurance that the correct high voltage will be applied, by the instrument, to the detector.

Press MODE key to exit the Parameters Mode.

8. Changing Count time (Scaler Mode)

The count time parameter is only relevant for the Scaler Mode and does not appear in the Parameters Mode menu if any of the Ratemeter Modes have been selected. If you are operating the detector in the Integrating or Average Rate Scaler Mode the count time must be set. Enter the Parameters Mode and step through the items until the following display appears:

```
CNT FOR 0:01:00        (hrs: mins: secs)
SCALER MODE
```

Note that the default time is one minute. Press the RESET and "+" key to increase the count time or press the RESET and "-" key to decrease the count time. Press MODE key to exit the Parameters Mode.

H. USING THE LOG MODE

The following functions may be performed from the Log Mode:

- Display the log data (access level 1 or greater).
- Transfer the log data to a printer or computer (access level 1 or greater).
- Reset the log, i.e., erase from memory all stored data points (access level 2 or greater).
- Change the baud rate (access level 4).
- Change the output format (access level 4).

1. **Entering the Log Mode and Stepping through the Menu (see Figure 3-15)**

Press MODE key and observe this display:

LOG THIS VALUE?
(ratemeter reading)

Press "-" and observe this display:

R/LOG -/PARAMS
+/OPER S/CLOCK

To select the Log Mode press RESET key. If there is data in memory to be output, then the following display will appear:

OUTPUT LOG DATA?
"+" = YES

To step through the Log Mode menu, press "-" to answer no:

DISPLAY LOG DATA?
"+" = YES

If "+" was pressed the instrument would enter a routine to display the data. Press "-" and the following display appears:

RESET LOG DATA?
"+" = YES

Pressing "+" will reset the data memory to zero and the next menu item would appear. Press "-" and the next menu item will appear:

PRINTER FORMAT
xxxx BAUD
"RESET" TO CHG.

From this menu item you can select printer format or computer format and the baud rate. If printer format has been selected the instrument can output to a printer on the RS-232 line. If you select the computer format, the instrument can communicate with a computer. On entering the Computer Format Mode from the Log Mode, we will be prompted with the following display:

COMMUNICATE?
"+" = YES

If we press "+" then the following display will appear:

COMPUTER LINK
"RESET" WHEN DONE

If the RS-232 Data-Set-Ready input line is active (positive input voltage), the computer may control the instrument without intervention by the user. Otherwise, the instrument will be locked out of further functioning until the DSR input is inactive or the MODE key is pressed.

2. Changing Output Format and Baud Rate

There are two output formats with which the SRM-200 operates: printer format and computer format. The printer format is employed when it is desired to output the log data to a printer. The computer format is employed when it is desired to interface with a computer. Both interfaces are through the RS-232 connector at the rear of the instrument. The computer format allows bi-directional communication with the attached computer.

See Communication Specification 13000-A08. It is possible for the computer to control, remotely, the operation of the SRM-200 via the RS-232 interface provided the SRM-200 is set in the computer format. Control is exercised by the computer when the RS-232 input line Data-Set-Ready (DSR) is high.

The SRM-200 RS-232 interface communicates with the printer or computer at a particular baud rate. The baud rate is the frequency in Hz at which the communication signal operates. Baud rates which may be selected in the SRM-200 are 150, 300, 600, 1200, 2400, 4800, 9600.

To output to a printer at 300 baud enter the Log Mode and step through the menu as in the previous section until the following display appears:

```
COMPUTER FORMAT
   2400 BAUD
"RESET" TO CHG.
```

Both the output format and the baud rate must be changed. Press the RESET key and the following display will appear:

```
COMPUTER FORMAT
 + = USE/- = NO
```

Press "-" and the display changes to:

```
PRINTER FORMAT
+ = USE/- = NO
```

Press "+" and the printer format is selected. The following display will appear:

```
   2400 BAUD
+ = USE/- = NO
```

Press "-" repeatedly until the following display appears:

300 BAUD
+ = USE/- = NO

Press "+" to use and the following display appears:

PRINTER FORMAT
300 BAUD
"RESET" TO CHG.

It would not have been necessary to go through the previous steps if the printer format and 300 baud rate had already been selected.

3. Transferring Log Data to a Printer

The logged data which is stored in memory may be output to a printer or an external peripheral device capable of accepting the RS-232 signal.

A certain amount of hardware handshaking is required in SRM-200/Printer interface. See Figure 2-3 which shows the minimal interconnecting cable connections. Some printers may require more handshaking. RTS, Pin 7, is wired "high" internally in the SRM-200 and outputs a high condition while the SRM-200 is powered on. DTR, Pin 4, gates high (positive voltage output) only when the SRM-200 is transmitting data. This information may be used to generate a more complex printer interface than the one shown.

```
SRM-200                STANDARD
RS-232 PORT             PRINTER
                      RS-232 PORT

TxD     3------------------>RxD
RxD     2
RTS     7
DSR     6<------------------DTR
GND     5-------------------GND
DTR     4
```

Figure 2-3, SRM-200/Printer Cable Interconnection Diagram

The SRM-200 will send out data at the baud rate selected as long as it detects a "NOT BUSY" signal on its DSR line. The type of peripheral device used will determine what output signal can be used as an input to the SRM-200 DSR line. In Figure 2-3 the standard DTR signal is used for this purpose. If the SRM-200 detects that DSR is no longer asserted it will "slow down" by sending characters at a rate of one character every 1/2 second. If the device re-asserts DSR, the SRM-200 will once again output at the rate determined by the hardware handshaking. In any case, the baud rate does not change, only the rate at which characters are sent.

With a cable connected to a printer as shown in Figure 2-3, data can be output to the printer. Enter the Log Mode. If no data has been stored in the log, the first display to appear is:

NO DATA STORED!

If, however, data has been stored in the log, then the following display will appear:

OUTPUT LOG DATA?
"+" = YES

Press the "+" key and the next display to appear is:

OUTPUTTING DATA
"+" TO PAUSE

The data is now being output to the printer. At the end of the data transfer, the instrument reverts back to its former operating mode. If we had pressed "+" to pause while the instrument was outputting data, the following display would have appeared:

RESET TO RESTART
"MODE" TO ABORT

If we press RESET, the heading and data would be output from the beginning. If we press MODE the output would be aborted and the instrument would revert back to its current operating mode.

Figure 2-4 is a sample printout. Note that the heading contains a six digit number for the instrument number, a nine digit number for the user I.D. number, the selected detector label, the operating mode of the instrument, and the detector calibration parameters, calibration constant, dead time, and high voltage.

Also, note in Figure 2-4 the manner the data is printed out. Along with each data point, the date, time of day, location code, and instrument status are printed. A blank in the status column represents that the monitored items are operating properly. If a "B" appears in the status column, then the battery was low when the measurement was taken. If an "A" appears in the status column, then the reading had exceeded the alarm setting. If an "H" appears, then a high voltage failure was present when the reading was taken. All combinations of the above letters are allowed in the status column.

4. Displaying Log Data

If data has been stored in the log, the data may be viewed on the display. Store some data in the log and then enter the Log Mode. Step through the log items until you get to the following display:

DISP. LOG DATA?
"+" = YES

Press "+" and the data may be viewed in two alternating displays as follows:

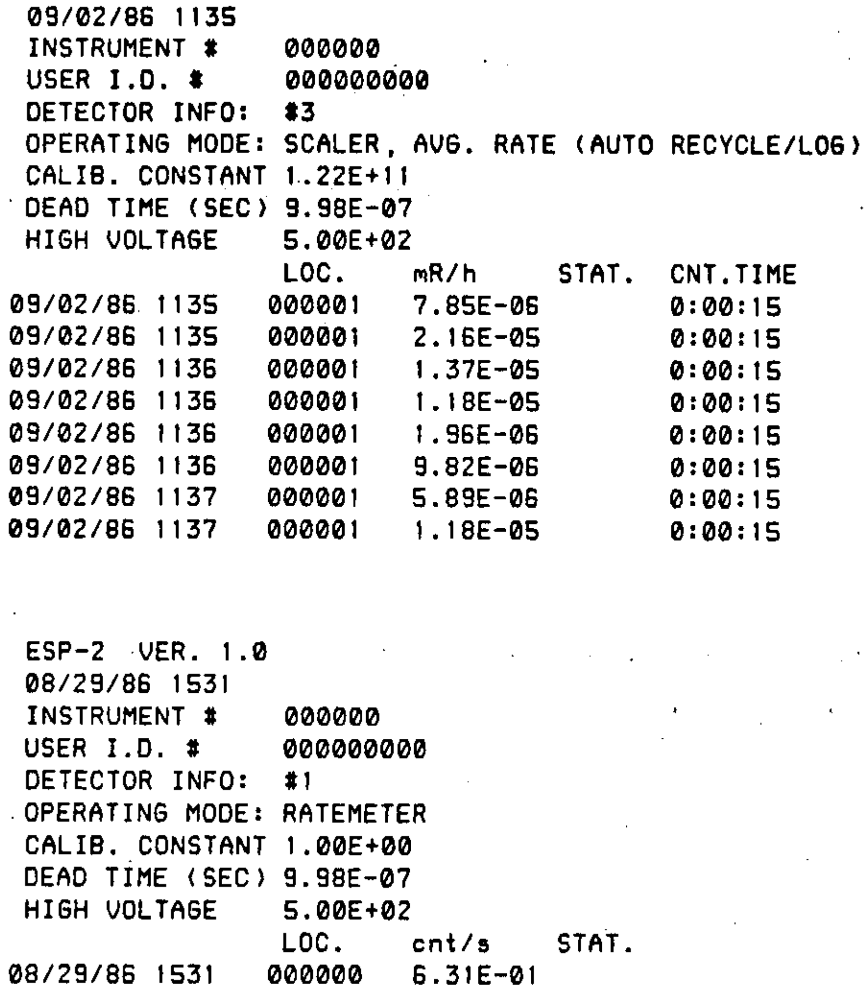
(date) (time)
LOC. xxxxxx

(detector no.)
(reading)

Repeatedly pressing "+" will step through the data with two alternating displays for each data point. Press MODE key to return to the current operating mode.

5. Resetting Log Data

After a series of measurements have been stored in the memory and have been output to a peripheral device, then you may want to erase the memory (reset it) and start storing a new series of measurements. The memory is not automatically erased when data is being output or after it is output. The only ways it is erased or reset is manually from the keypad or if the batteries are taken out for a long while and the instrument is "cold started".



```
 09/02/86 1135
 INSTRUMENT #     000000
 USER I.D. #      000000000
 DETECTOR INFO:   #3
 OPERATING MODE: SCALER, AVG. RATE (AUTO RECYCLE/LOG)
 CALIB. CONSTANT 1.22E+11
 DEAD TIME (SEC) 9.98E-07
 HIGH VOLTAGE     5.00E+02
                  LOC.     mR/h      STAT.   CNT.TIME
09/02/86 1135    000001   7.85E-06          0:00:15
09/02/86 1135    000001   2.16E-05          0:00:15
09/02/86 1136    000001   1.37E-05          0:00:15
09/02/86 1136    000001   1.18E-05          0:00:15
09/02/86 1136    000001   1.96E-06          0:00:15
09/02/86 1136    000001   9.82E-06          0:00:15
09/02/86 1137    000001   5.89E-06          0:00:15
09/02/86 1137    000001   1.18E-05          0:00:15


 ESP-2  VER. 1.0
 08/29/86 1531
 INSTRUMENT #     000000
 USER I.D. #      000000000
 DETECTOR INFO:   #1
 OPERATING MODE: RATEMETER
 CALIB. CONSTANT 1.00E+00
 DEAD TIME (SEC) 9.98E-07
 HIGH VOLTAGE     5.00E+02
                  LOC.     cnt/s     STAT.
08/29/86 1531    000000   6.31E-01
```

Figure 2-4, Printer Heading and Data Format, 11383-A35

To reset memory from the keypad, the instrument must be set for access level two or greater. Enter the Log Mode and step through the menu, pressing the "-" key (since "+" answers "yes" to the items being stepped through), until the following display appears:

RESET LOG DATA?
"+" = YES

Press "+" key. The memory is reset to zero and the next item in the menu appears. Press the MODE key to exit the Log Mode and to return to the current operating mode.

I. SIMPLE TROUBLESHOOTING

Although detailed troubleshooting will be given in Section V, three simple suggestions for troubleshooting will be given here.

1. Condition: Blinking character or letter display.

   If the character in the upper left hand corner of the display is blinking, the DC power supply output could need adjustment. Or, if operating the instrument away from AC power, the internal battery needs recharging. Plug the instrument into an AC line to recharge.

2. Condition: Display prints erratic numbers or figures, is blank, or has unallowable access levels.

   If the display shows characters or letters which are not a part of the usual display mode, the program in the microprocessor may have lost its initialization. To correct this condition and reinitialize the instrument, perform the following procedure:

   CAUTION

   Reinitializing the microprocessor resets ALL parameters, including the high voltage readout calibration. After reinitializing complete recalibration must be performed before using the instrument.

   a. Disconnect AC power from the instrument. Remove the back cover to the instrument. Disconnect the "+" lead (red) from the Gel-type battery inside of the instrument.

   b. Press the RESET pushbutton switch S5, on the etch side of the exposed bottom printed circuit board. This will discharge C28. Press RESET button for at least 10 seconds to make sure C28 is completely discharged.

   c. Reconnect the battery lead (red) in the instrument and re-install the case bottom.

   d. Turn on the instrument and determine if the condition is corrected; that is, that the display presents letters and numbers which are a part of the usual display modes and are "reasonable".

e. If the display is still not functioning correctly repeat a. through d. If still not functioning, you may wish to consult detailed troubleshooting in Section V or return your instrument to the factory for repair.

f. Note that all calibration parameters and preprogrammed data have been erased and will have to be re-entered.

3. Condition: Display always in the Log Mode.

If the following display occurs and appears to be locked in such that nothing will happen if you press any key,

COMPUTER LINK
WAITING FOR COMM

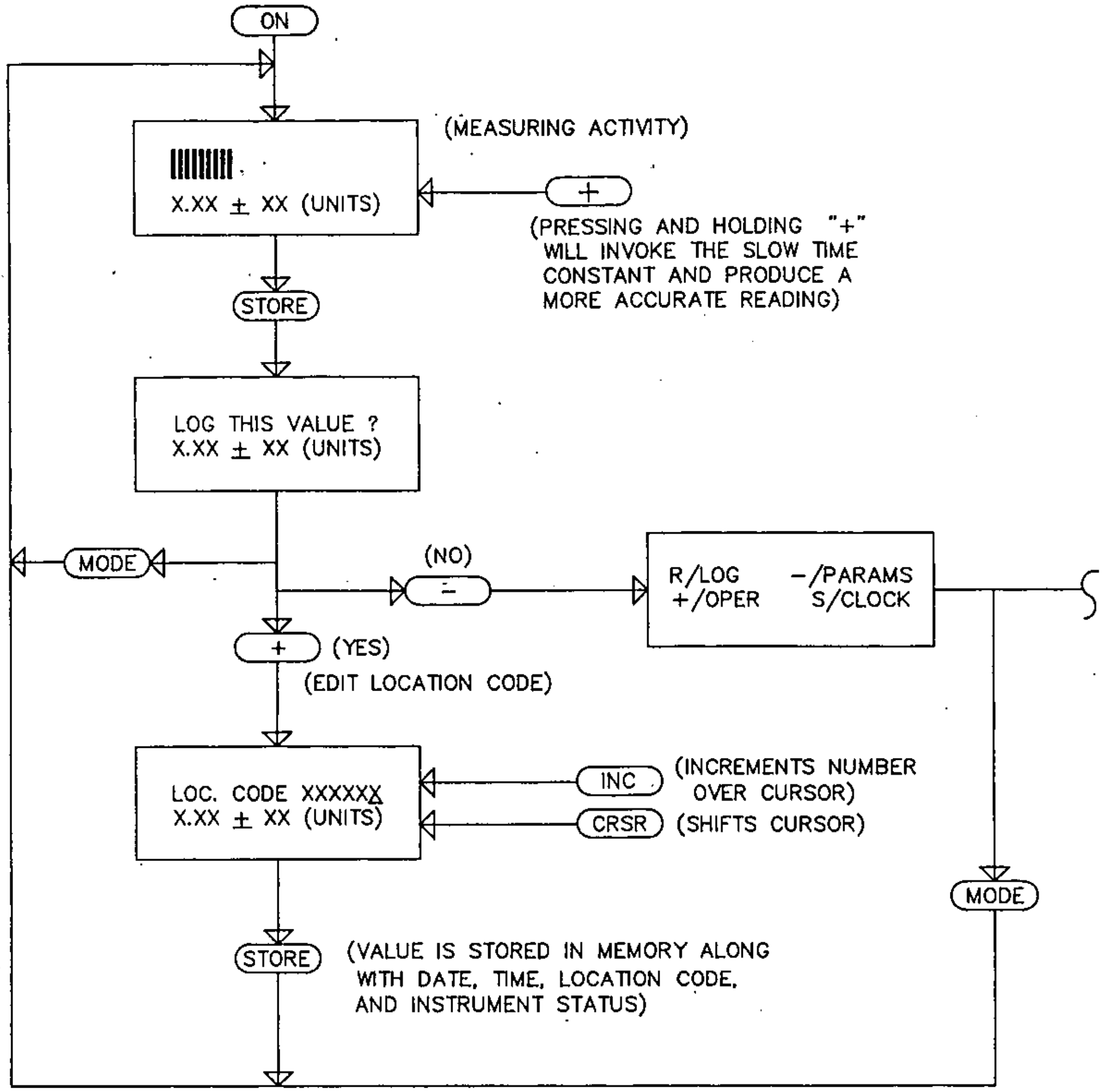
the most probable cause is that computer format has been set from the Log Mode and a cable is attached to the RS-232 connector with a signal on pin 6, DSR, which is holding it high. Remove the signal or cable and the problem will be corrected.

Section 3

SECTION III. FUNCTIONAL FLOW DIAGRAMS

Figure 3-1 thru Figure 3-15 are SRM-200 functional flow diagrams which show in simplified form the control key operation and expected displays for all modes which the SRM-200 may operate in. In all these flow diagrams, the "flow" start at the top and goes toward the bottom. In learning SRM-200 operation, it would be very helpful for the user to operate the instrument as he studies these functional flow diagrams. The diagrams provide feedback to a user verifying proper control key operation.

Before operating the instrument make sure that the instrument is set up properly for the detector employed with the instrument. Most operational features may be exercised without a detector in which case the detector may be disconnected.


ON
(MEASURING ACTIVITY)
X.XX ± XX (UNITS)
+
(PRESSING AND HOLDING "+" WILL INVOKE THE SLOW TIME CONSTANT AND PRODUCE A MORE ACCURATE READING)
STORE
LOG THIS VALUE ?
X.XX ± XX (UNITS)
MODE
(NO)
−
R/LOG −/PARAMS
+/OPER S/CLOCK
+ (YES)
(EDIT LOCATION CODE)
LOC. CODE XXXXXX
X.XX ± XX (UNITS)
INC
(INCREMENTS NUMBER OVER CURSOR)
CRSR
(SHIFTS CURSOR)
MODE
STORE
(VALUE IS STORED IN MEMORY ALONG WITH DATE, TIME, LOCATION CODE, AND INSTRUMENT STATUS)

ESP−2 FUNCTIONAL FLOW DIAGRAM

NOTES FOR BLOCK DIAGRAMS

1. ⬭ = KEY INPUT
2. ▭ = DISPLAY
3. (UNITS) = CURRENT SELECTED UNITS, e.g. cnt/s
4. (NOTE) = EXPLANATION NOTE
5. ⬚ = INTERNAL FUNCTION NOT DISPLAYED

Figure 3-1, Normal Ratemeter Mode, 11383-C13

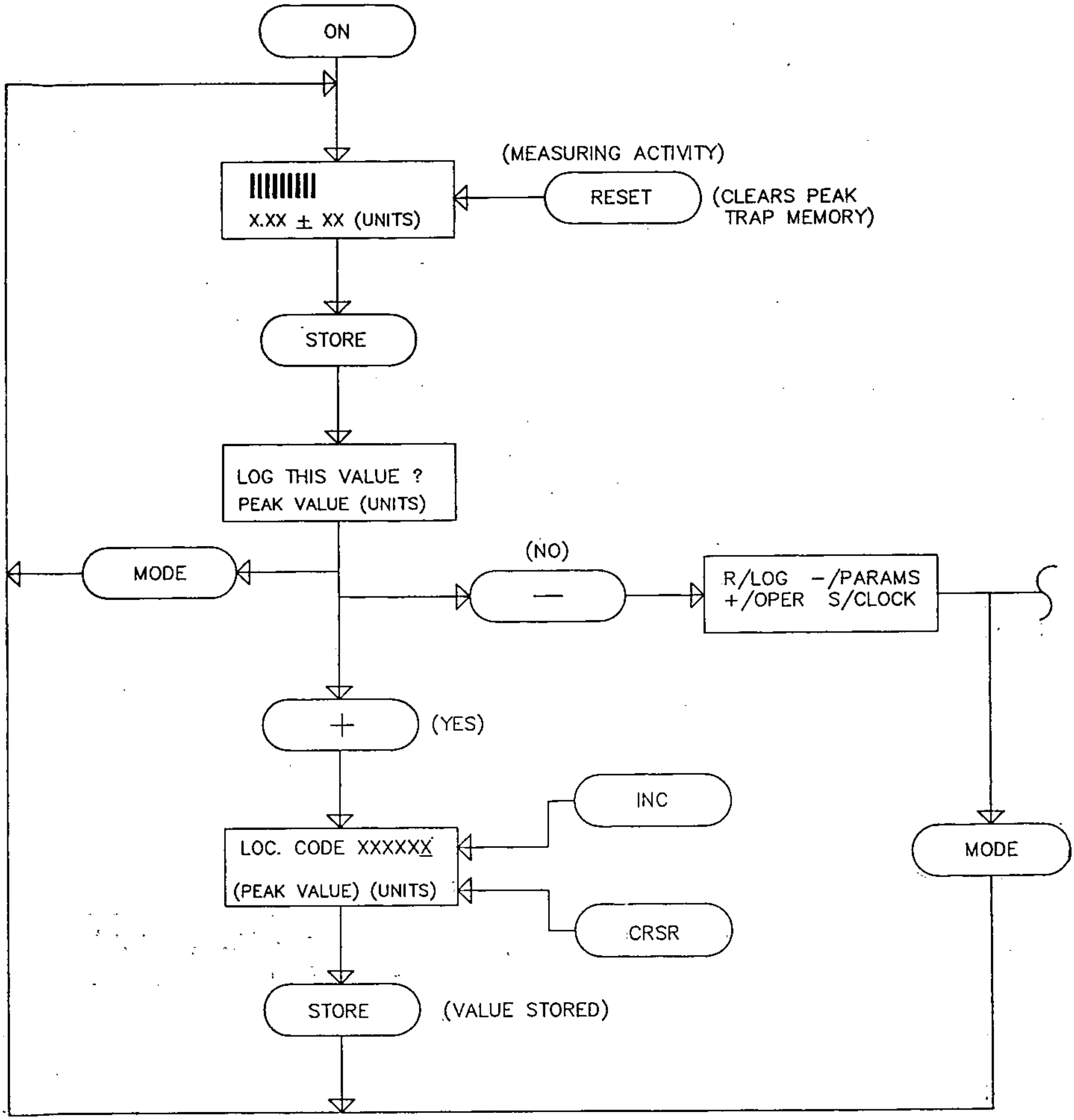


Figure 3-2, Peak Trap Ratemeter Mode, 11383-C12

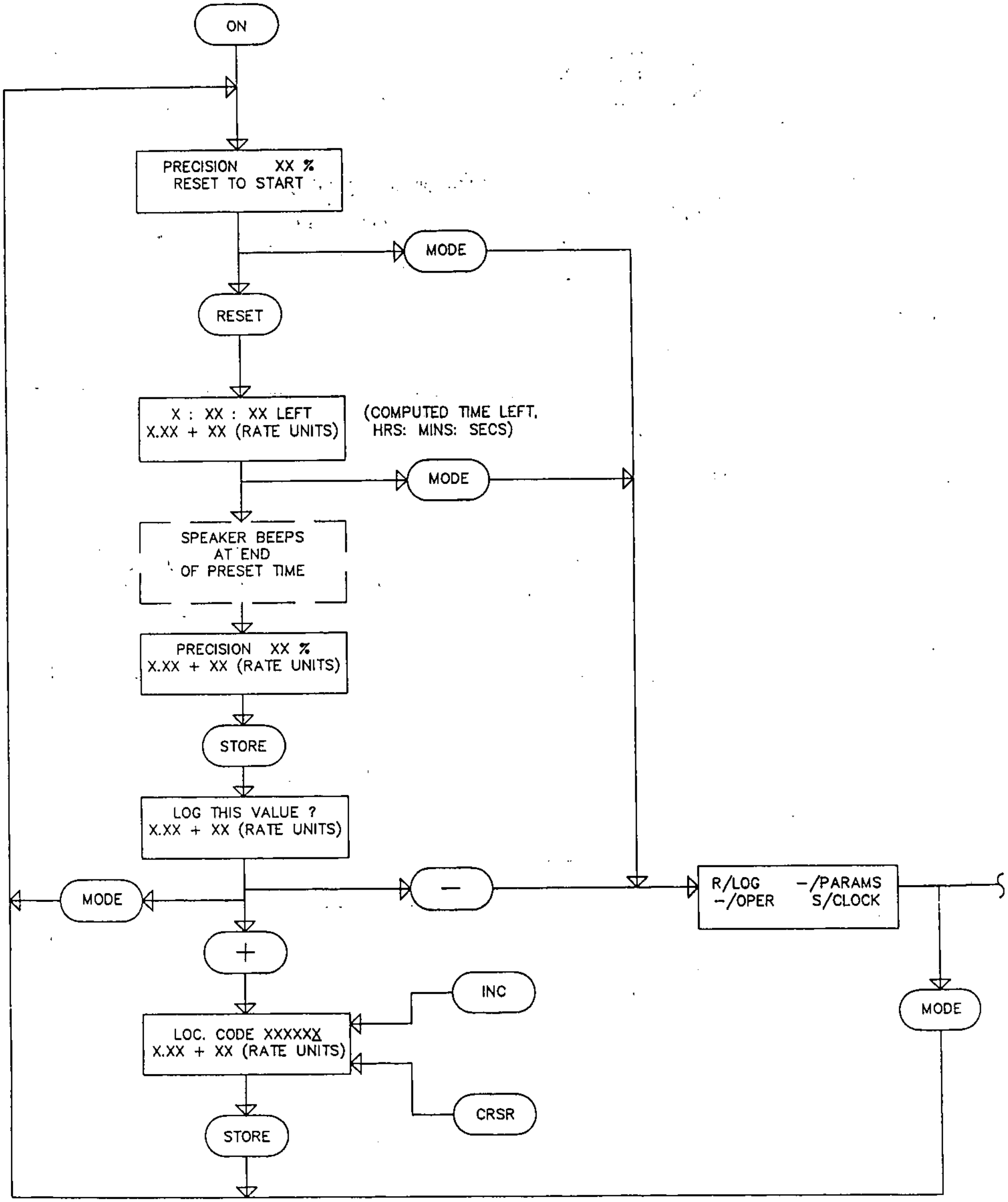


Figure 3-3, Fixed Precision Scaler Mode, 11383-C16

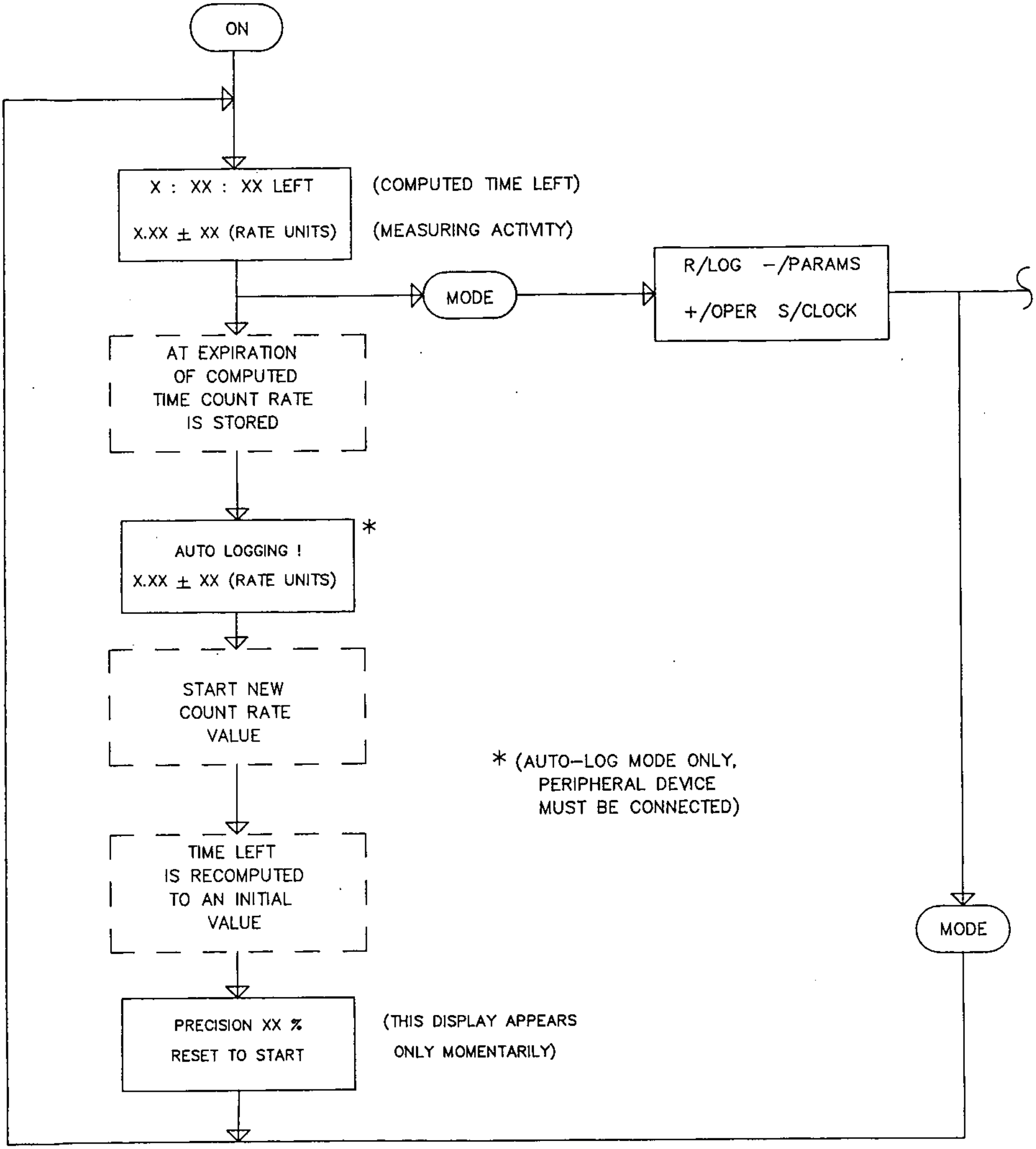

ON
X : XX : XX LEFT
X.XX ± XX (RATE UNITS)
(COMPUTED TIME LEFT)
(MEASURING ACTIVITY)
MODE
R/LOG -/PARAMS
+/OPER S/CLOCK
AT EXPIRATION OF COMPUTED TIME COUNT RATE IS STORED
AUTO LOGGING !
X.XX ± XX (RATE UNITS)
*
START NEW COUNT RATE VALUE
* (AUTO-LOG MODE ONLY, PERIPHERAL DEVICE MUST BE CONNECTED)
TIME LEFT IS RECOMPUTED TO AN INITIAL VALUE
MODE
PRECISION XX %
RESET TO START
(THIS DISPLAY APPEARS ONLY MOMENTARILY)

Figure 3-4, Fixed Precision Scaler Mode with Auto-recycle, Auto-store, and Auto-log, 11383-C15

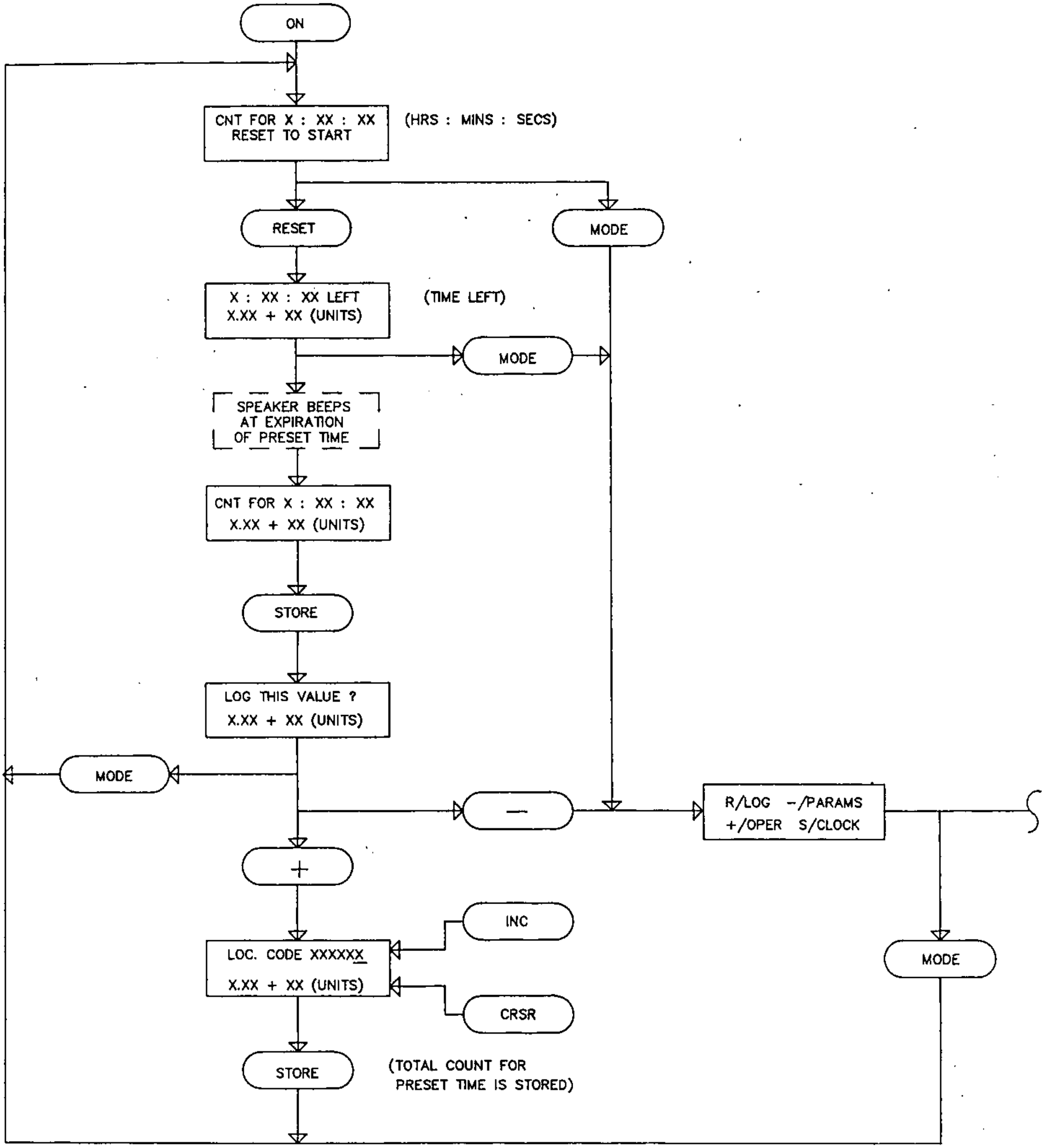
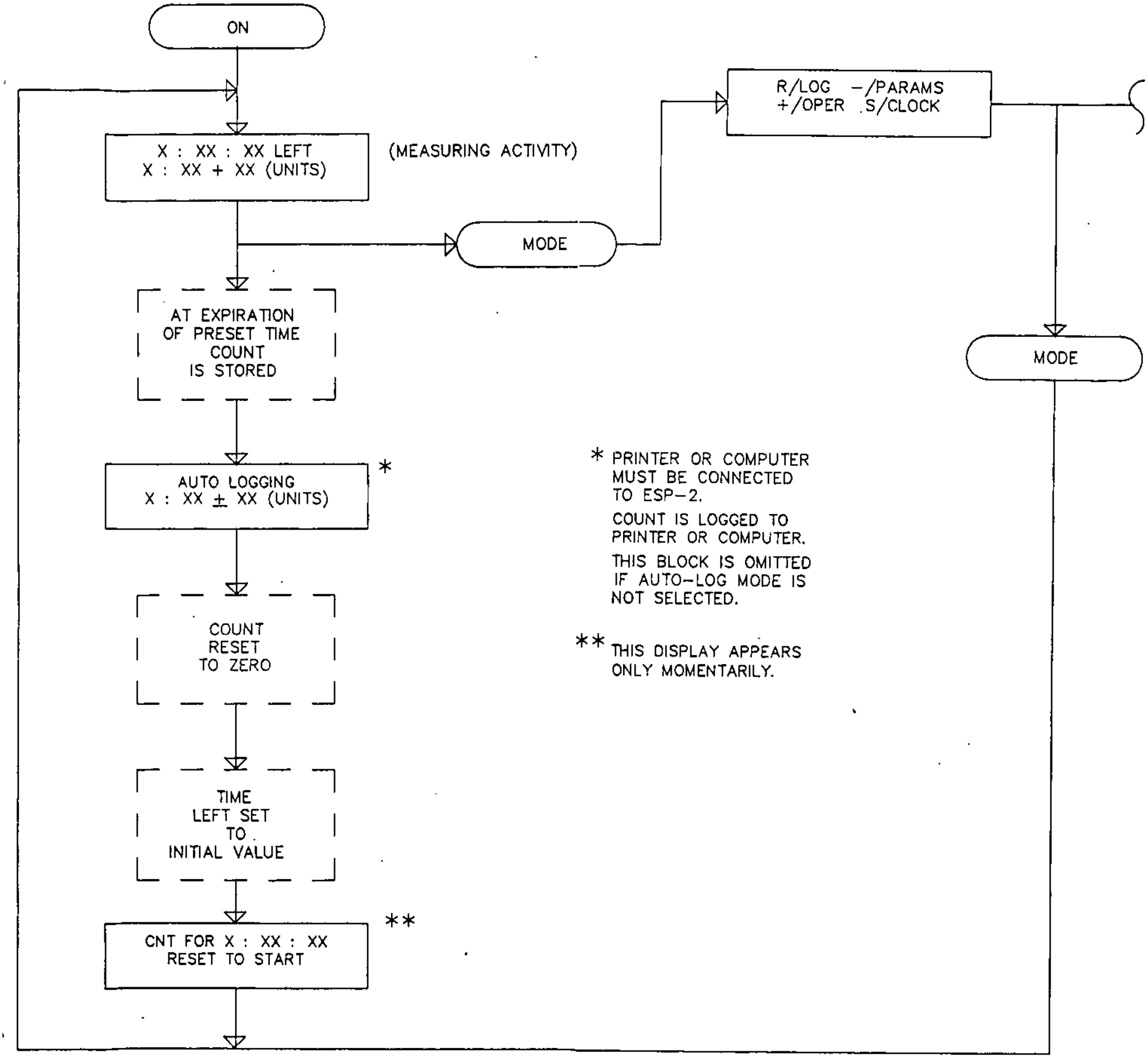


Figure 3-5, Integrating Scaler Mode, 11383-C14



* PRINTER OR COMPUTER MUST BE CONNECTED TO ESP–2.

COUNT IS LOGGED TO PRINTER OR COMPUTER.

THIS BLOCK IS OMITTED IF AUTO–LOG MODE IS NOT SELECTED.

** THIS DISPLAY APPEARS ONLY MOMENTARILY.

Figure 3-6, Integrating Scaler Mode with Auto-recycle, Auto-store, and Auto-log, 11383-C17

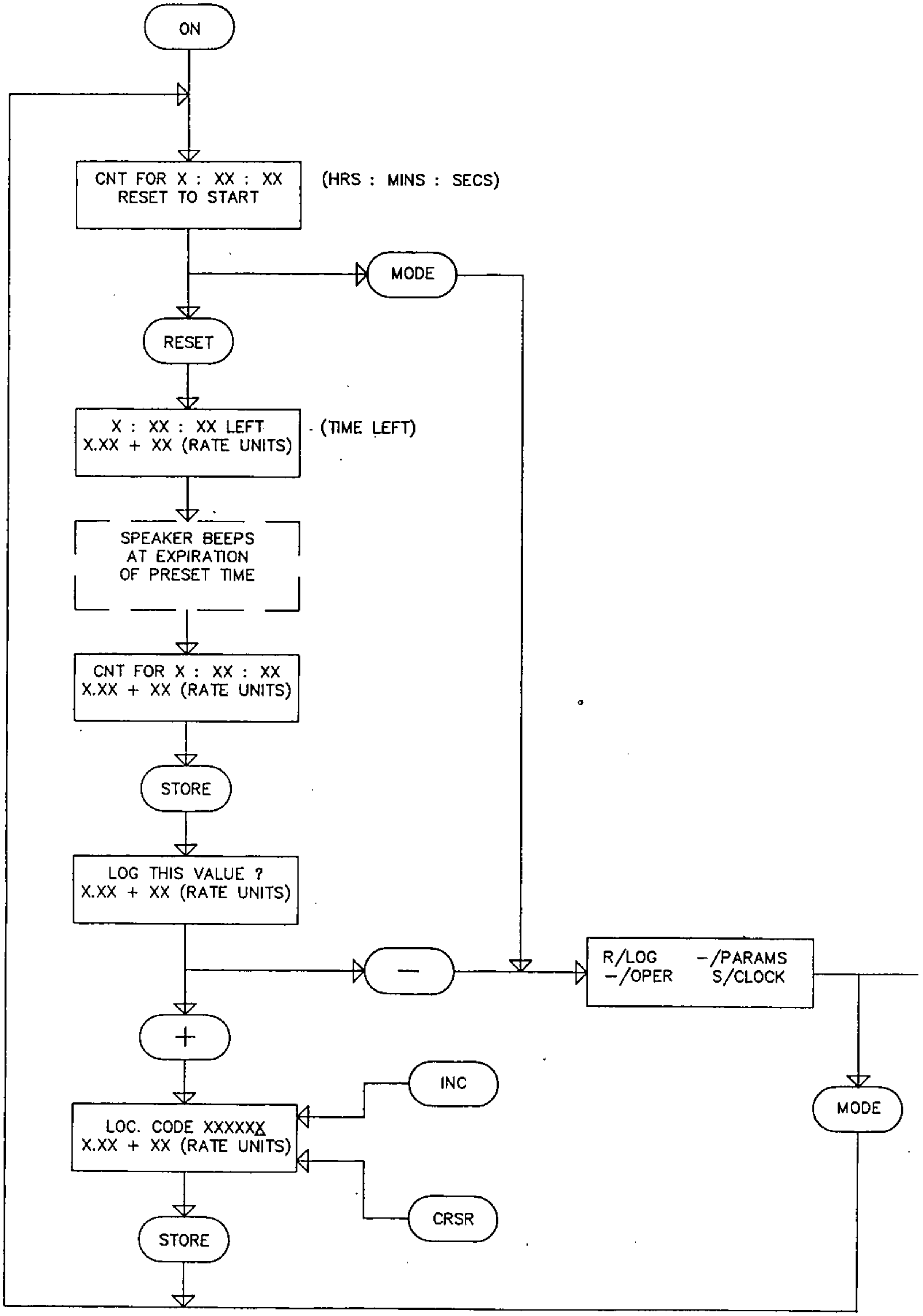
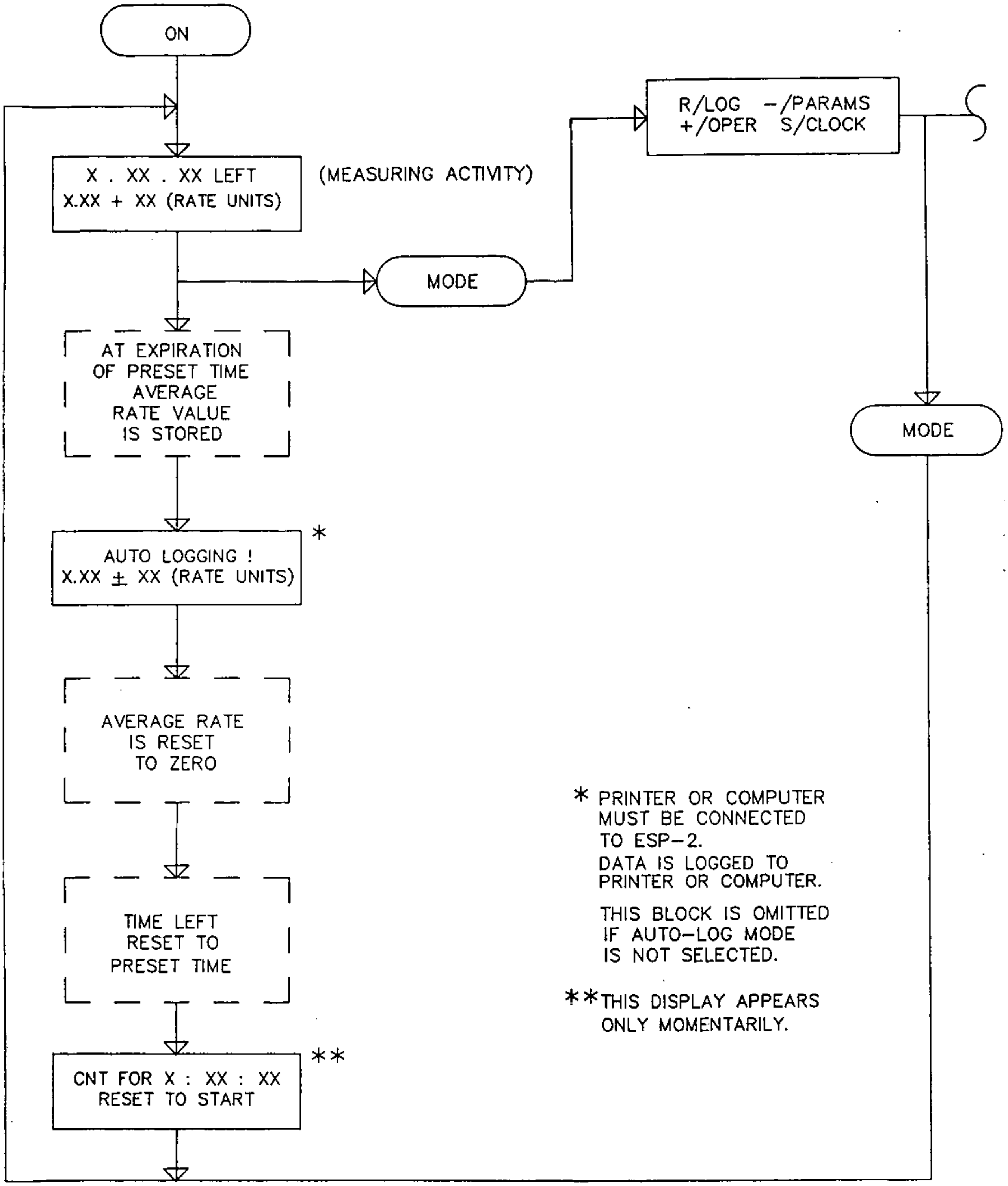


Figure 3-7, Average Rate Scaler Mode, 11383-C18



* PRINTER OR COMPUTER MUST BE CONNECTED TO ESP-2.
DATA IS LOGGED TO PRINTER OR COMPUTER.
THIS BLOCK IS OMITTED IF AUTO-LOG MODE IS NOT SELECTED.

** THIS DISPLAY APPEARS ONLY MOMENTARILY.

Figure 3-8, Average Rate Scaler Mode with Auto-recycle, Auto-store, and Auto-log, 11383-C19

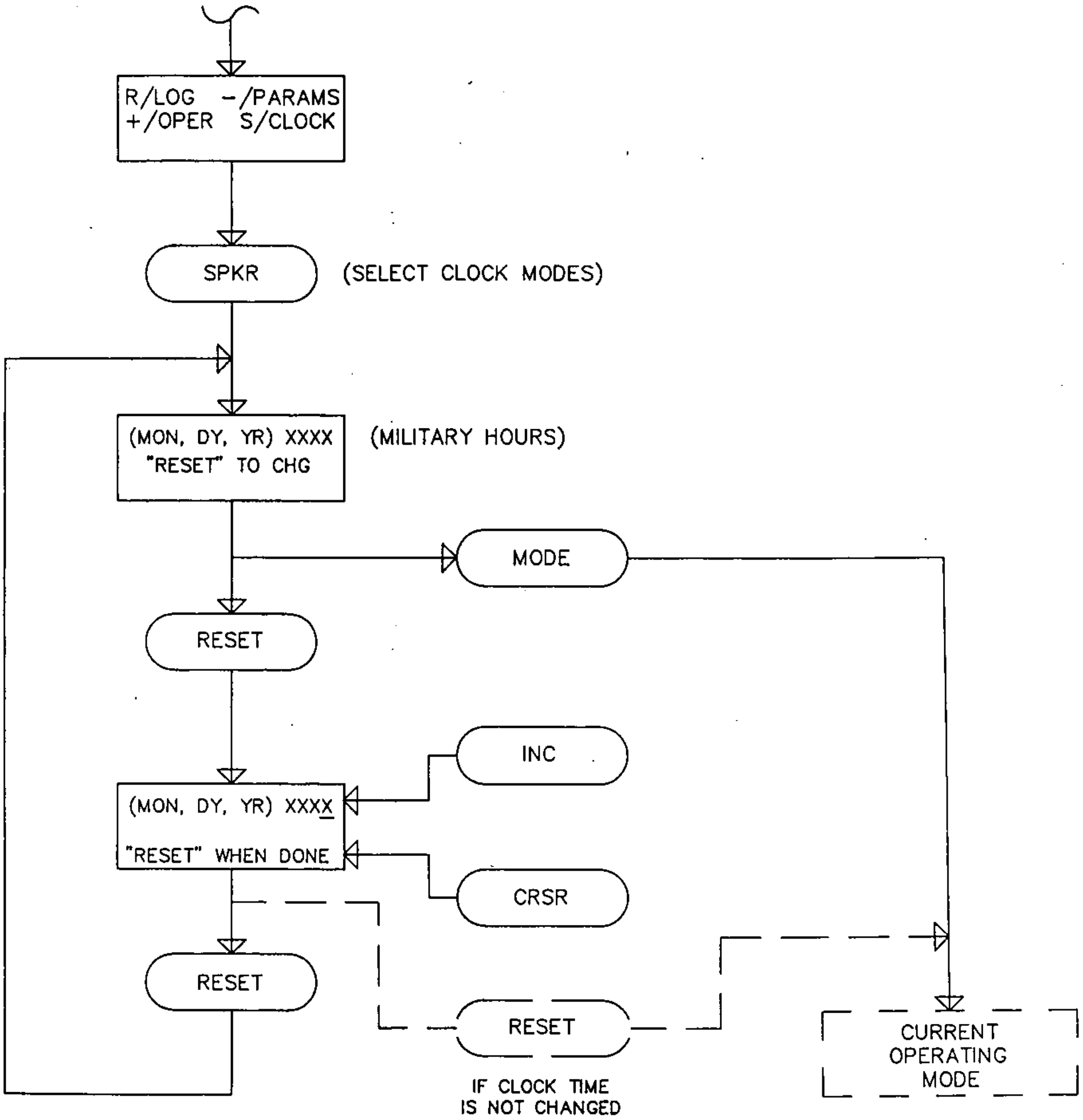


Figure 3-9, Clock Mode, 11383-C20

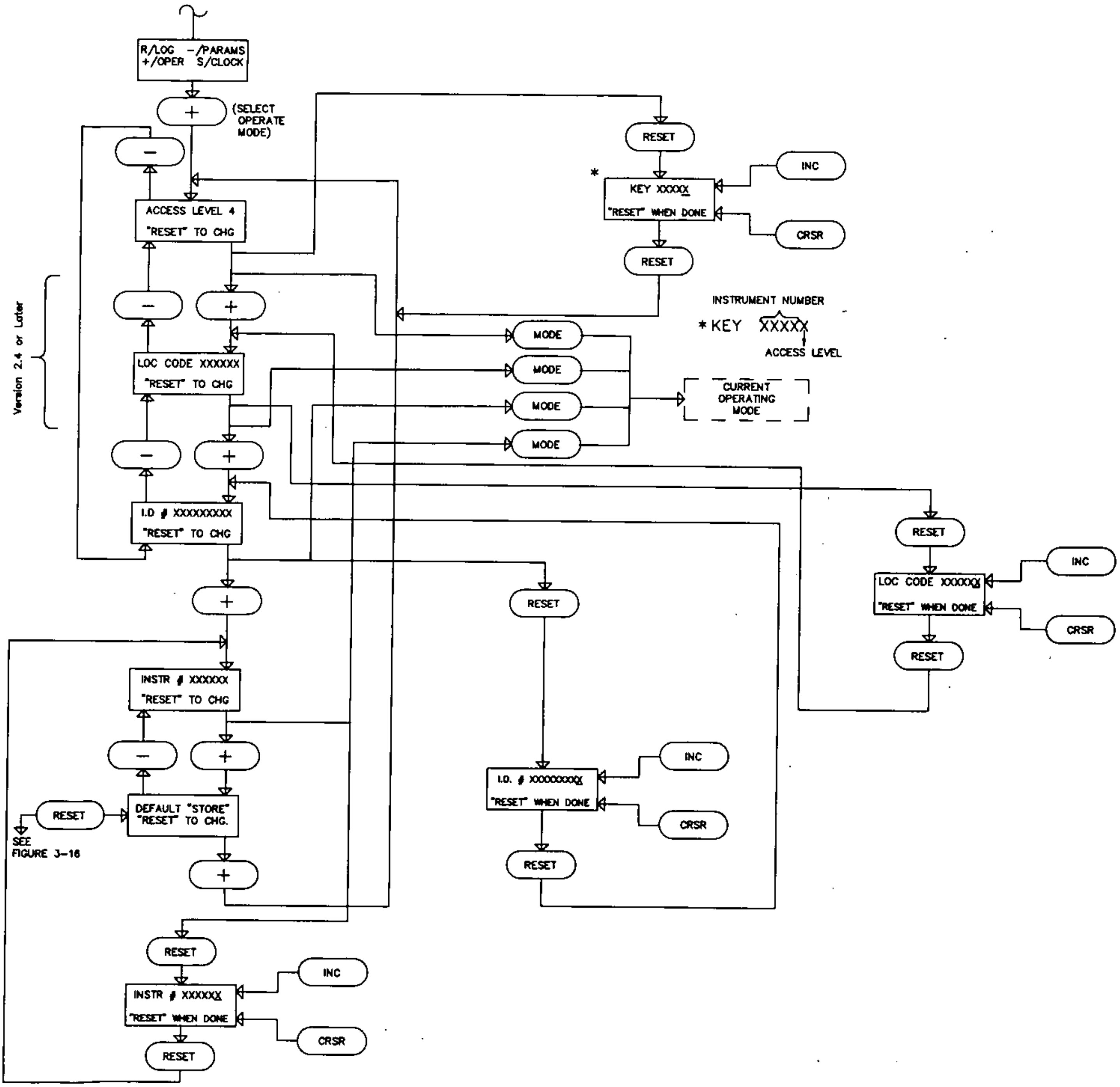
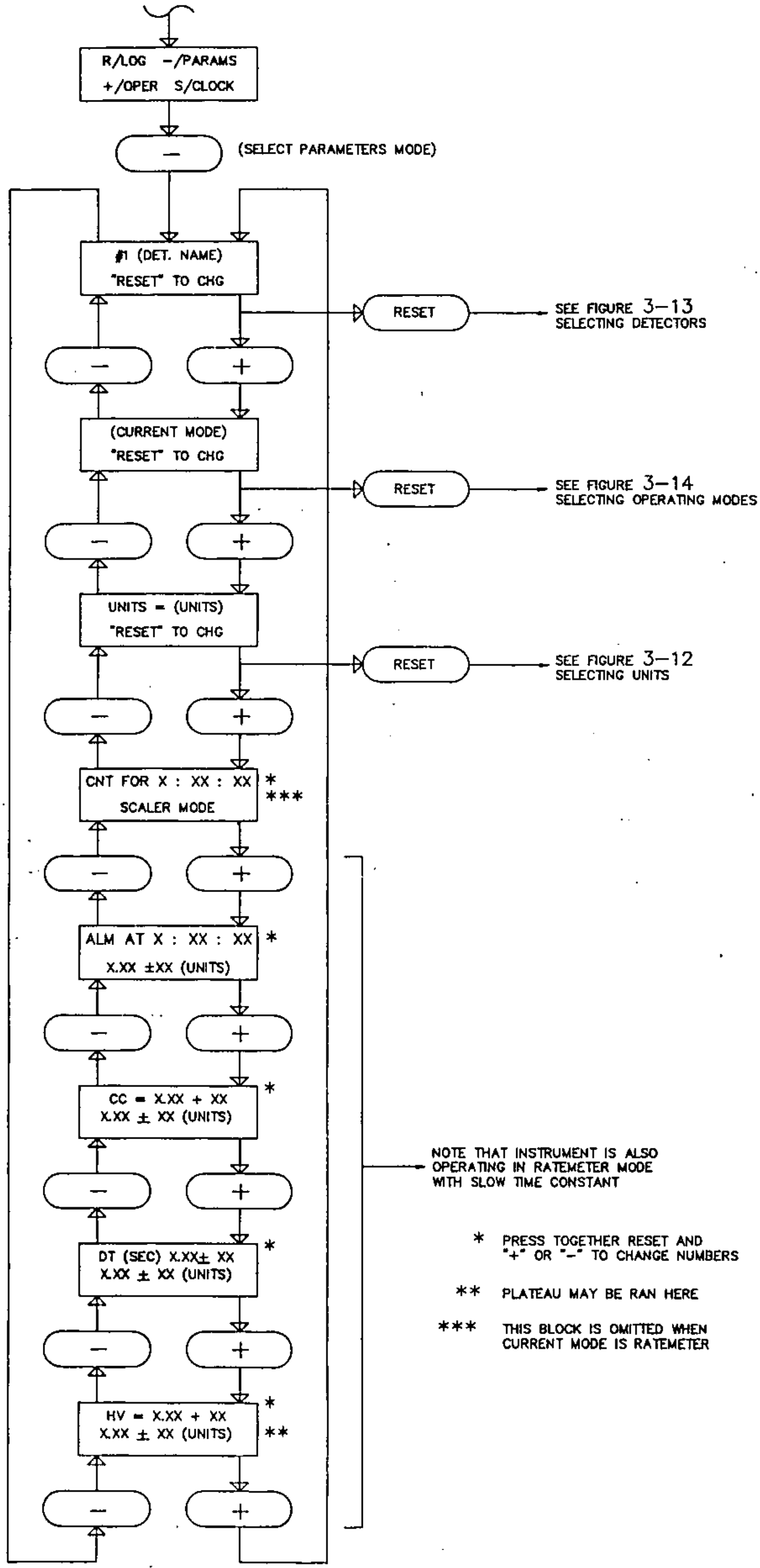


Figure 3-10, Operate Mode, 11383-C21A



NOTE THAT INSTRUMENT IS ALSO OPERATING IN RATEMETER MODE WITH SLOW TIME CONSTANT

* PRESS TOGETHER RESET AND "+" OR "–" TO CHANGE NUMBERS

** PLATEAU MAY BE RAN HERE

*** THIS BLOCK IS OMITTED WHEN CURRENT MODE IS RATEMETER

Figure 3-11, Parameters Mode, 11383-C22

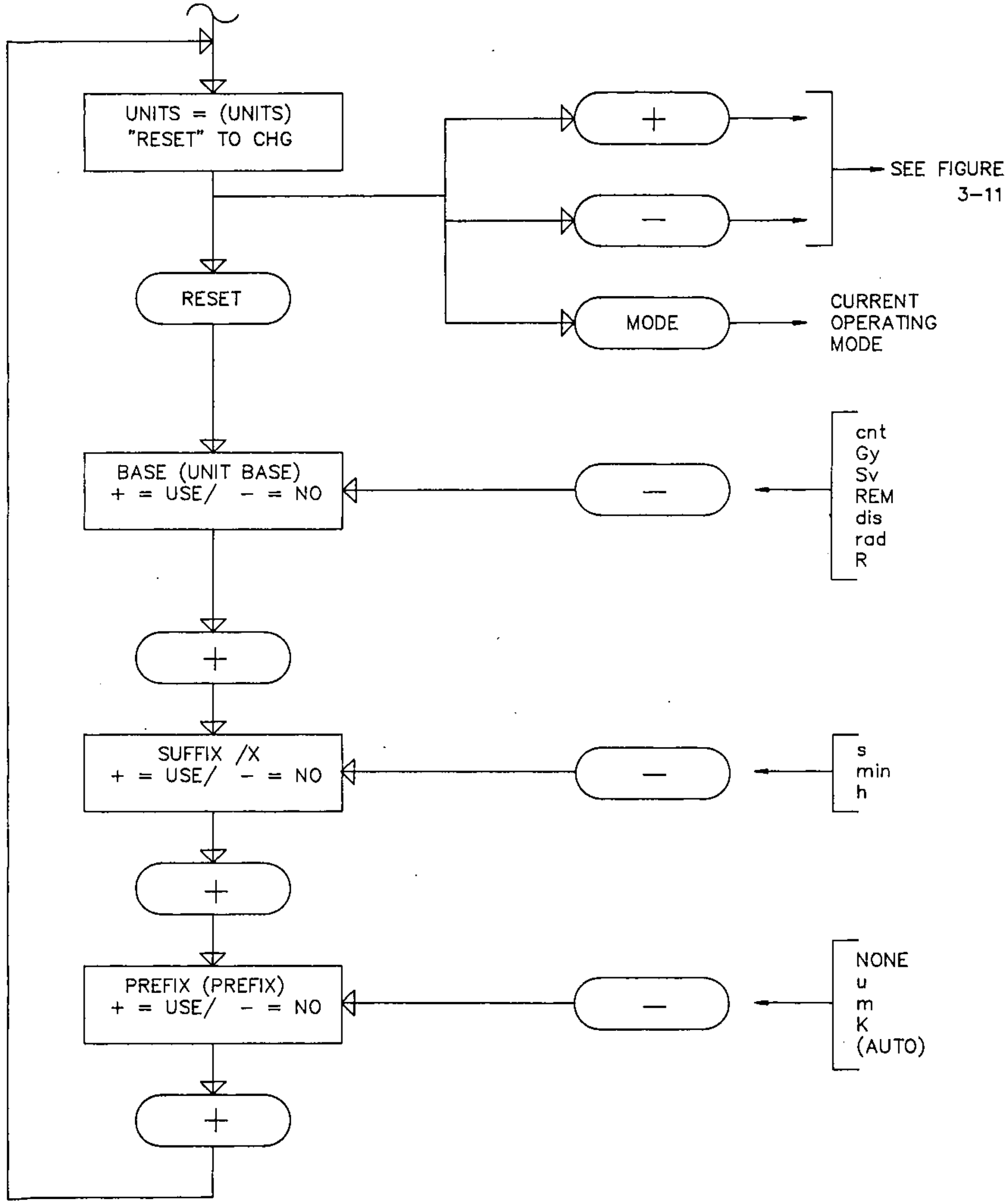


Figure 3-12, Selecting Units, 11383-C23

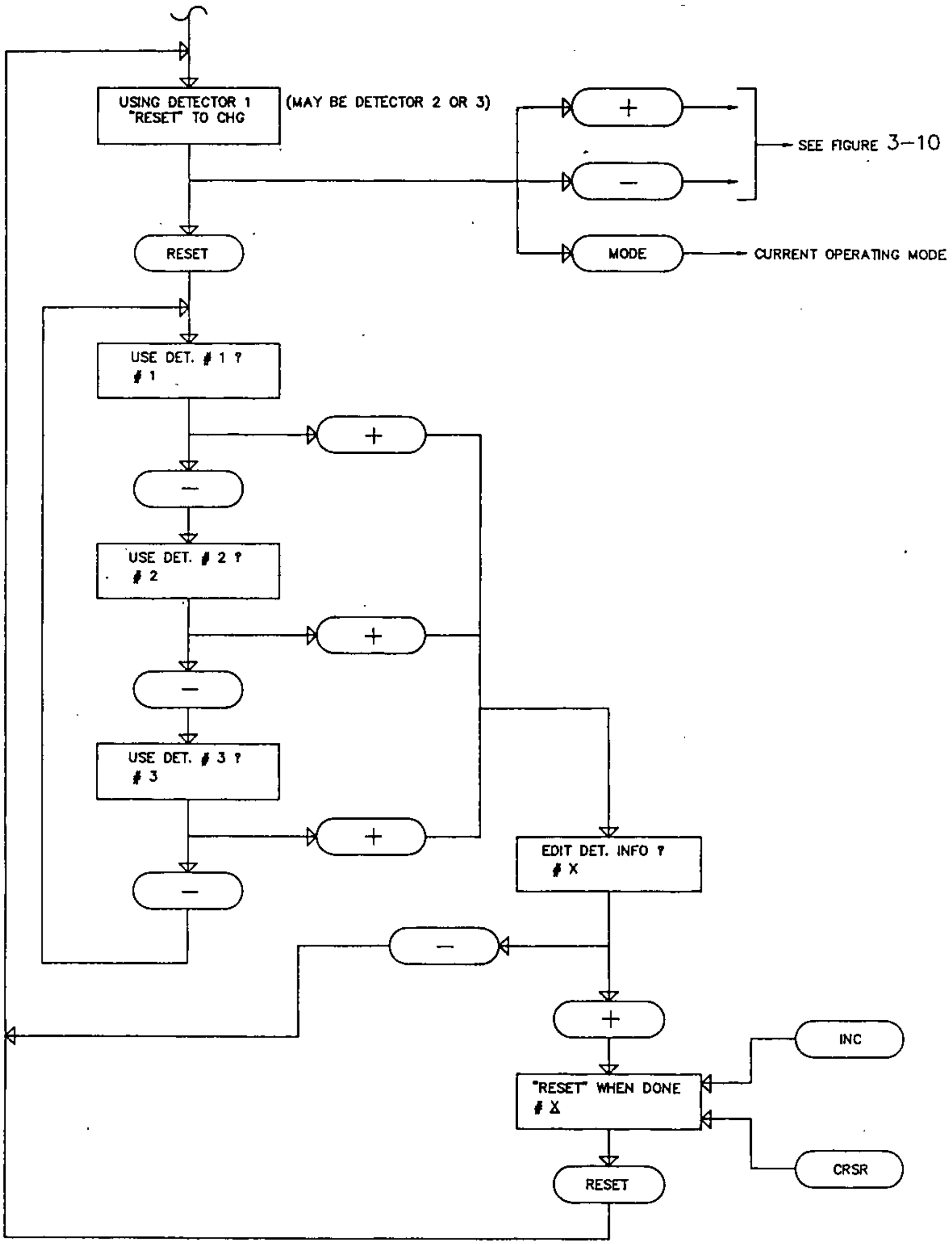


Figure 3-13, Selecting Detectors, 11383-C24

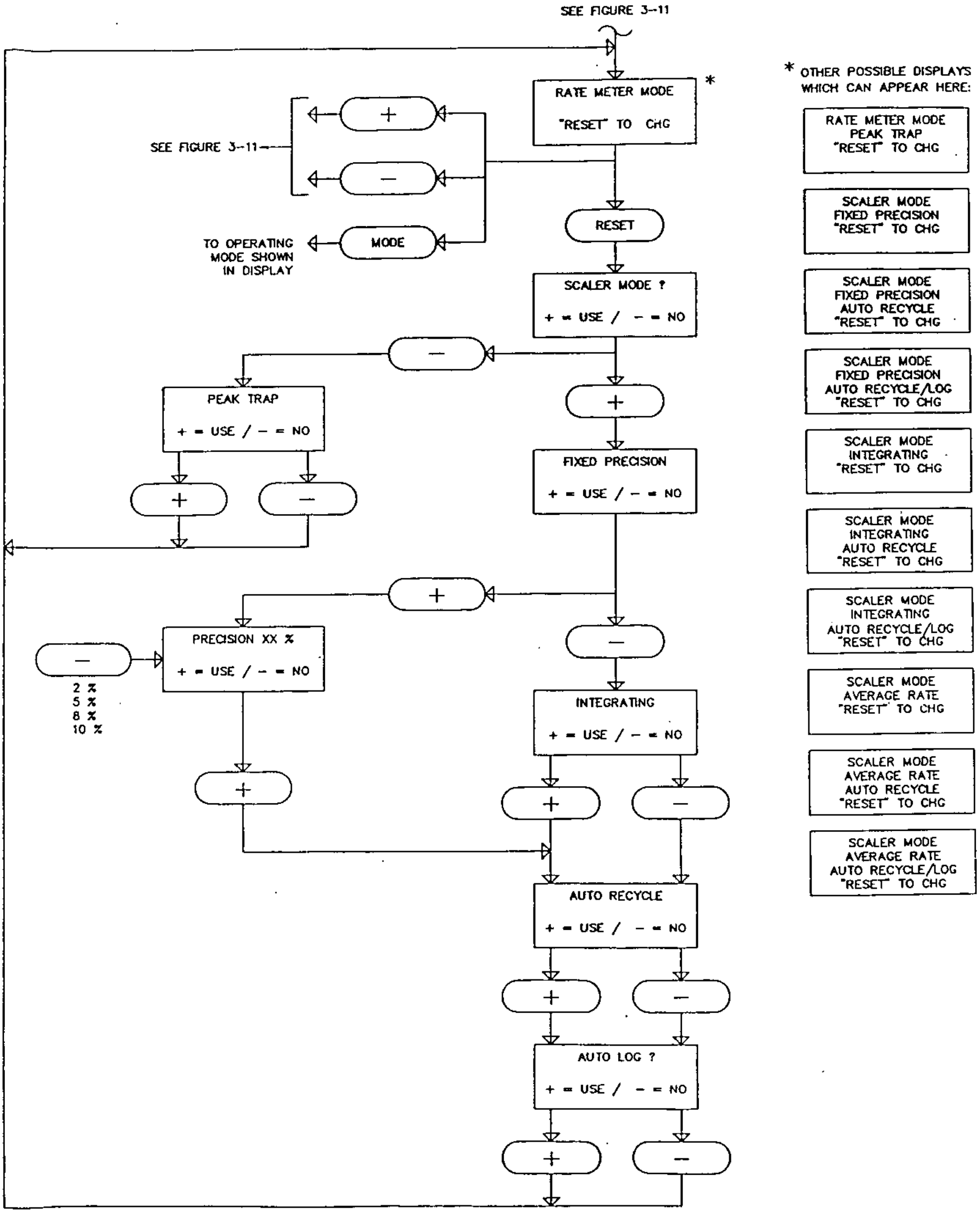

SEE FIGURE 3-11
RATE METER MODE
"RESET" TO CHG
*
SEE FIGURE 3-11
+
−
MODE
TO OPERATING MODE SHOWN IN DISPLAY
RESET
SCALER MODE ?
+ = USE / − = NO
−
+
PEAK TRAP
+ = USE / − = NO
+
−
FIXED PRECISION
+ = USE / − = NO
+
PRECISION XX %
+ = USE / − = NO
−
2 %
5 %
8 %
10 %
+
−
INTEGRATING
+ = USE / − = NO
+
−
AUTO RECYCLE
+ = USE / − = NO
+
−
AUTO LOG ?
+ = USE / − = NO
+
−
* OTHER POSSIBLE DISPLAYS WHICH CAN APPEAR HERE:
RATE METER MODE PEAK TRAP "RESET" TO CHG
SCALER MODE FIXED PRECISION "RESET" TO CHG
SCALER MODE FIXED PRECISION AUTO RECYCLE "RESET" TO CHG
SCALER MODE FIXED PRECISION AUTO RECYCLE/LOG "RESET" TO CHG
SCALER MODE INTEGRATING "RESET" TO CHG
SCALER MODE INTEGRATING AUTO RECYCLE "RESET" TO CHG
SCALER MODE INTEGRATING AUTO RECYCLE/LOG "RESET" TO CHG
SCALER MODE AVERAGE RATE "RESET" TO CHG
SCALER MODE AVERAGE RATE AUTO RECYCLE "RESET" TO CHG
SCALER MODE AVERAGE RATE AUTO RECYCLE/LOG "RESET" TO CHG

Figure 3-14, Selecting Operating Modes, 11383-C25

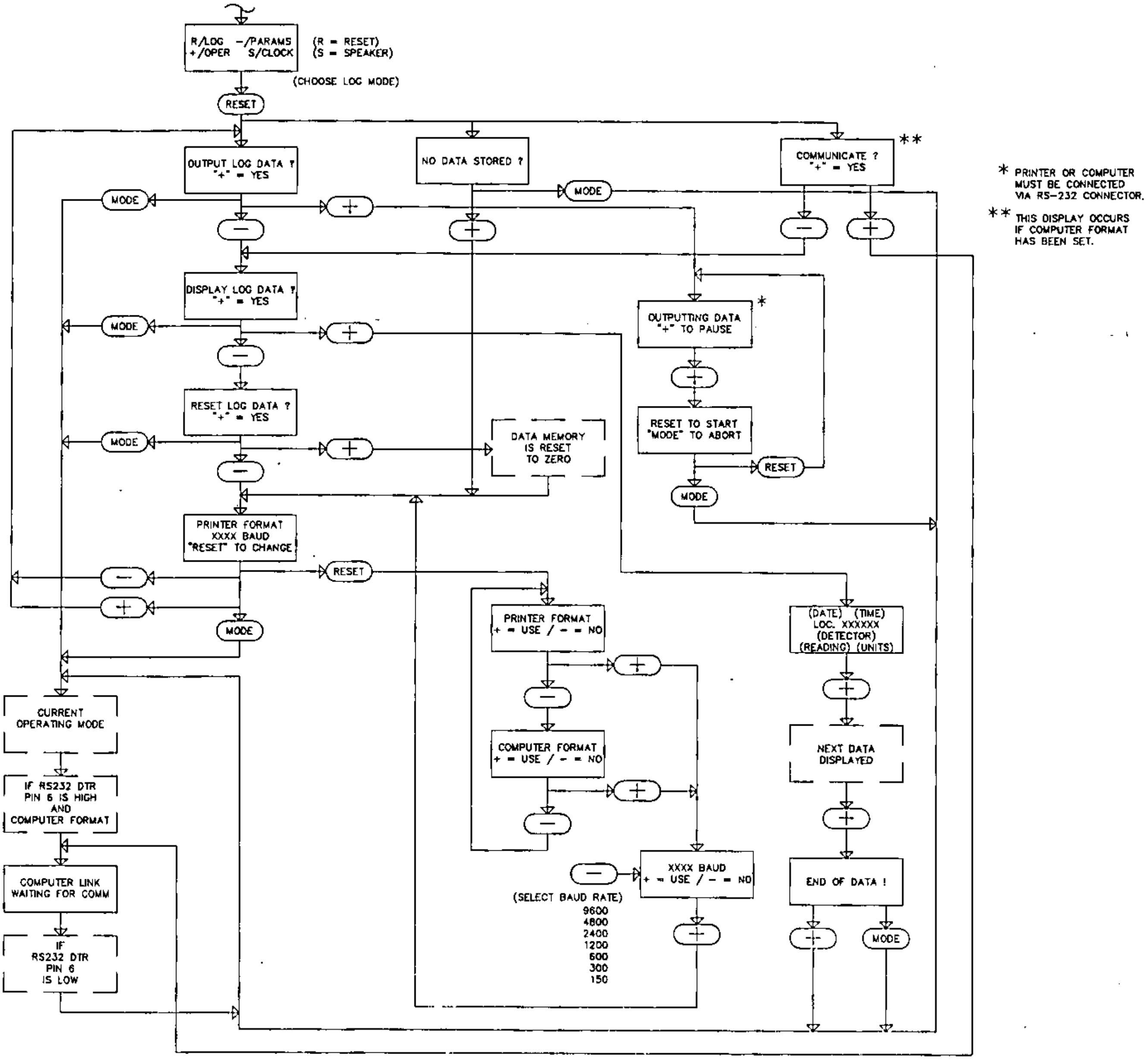


Figure 3-15, Log Mode, 11383-C26

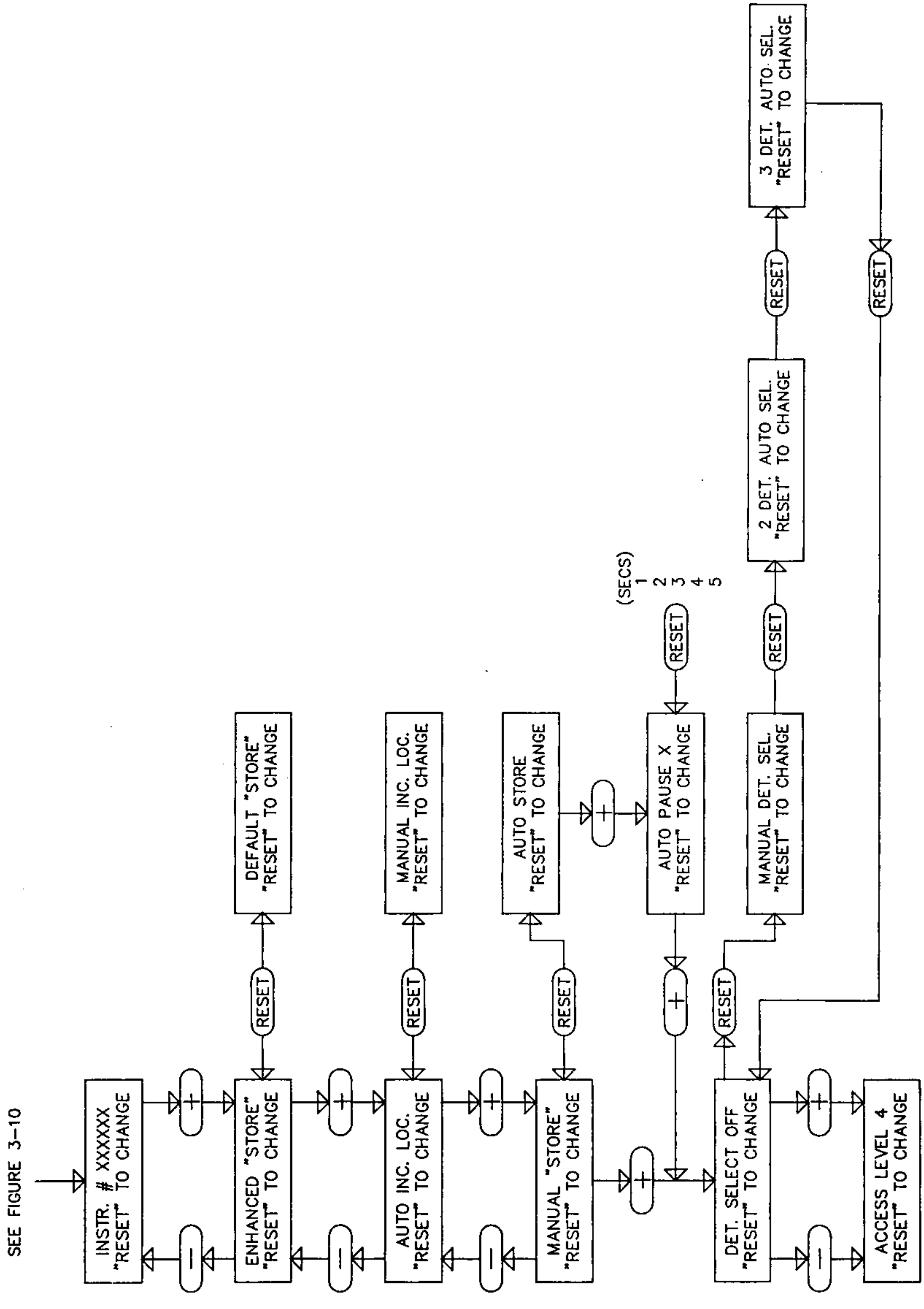
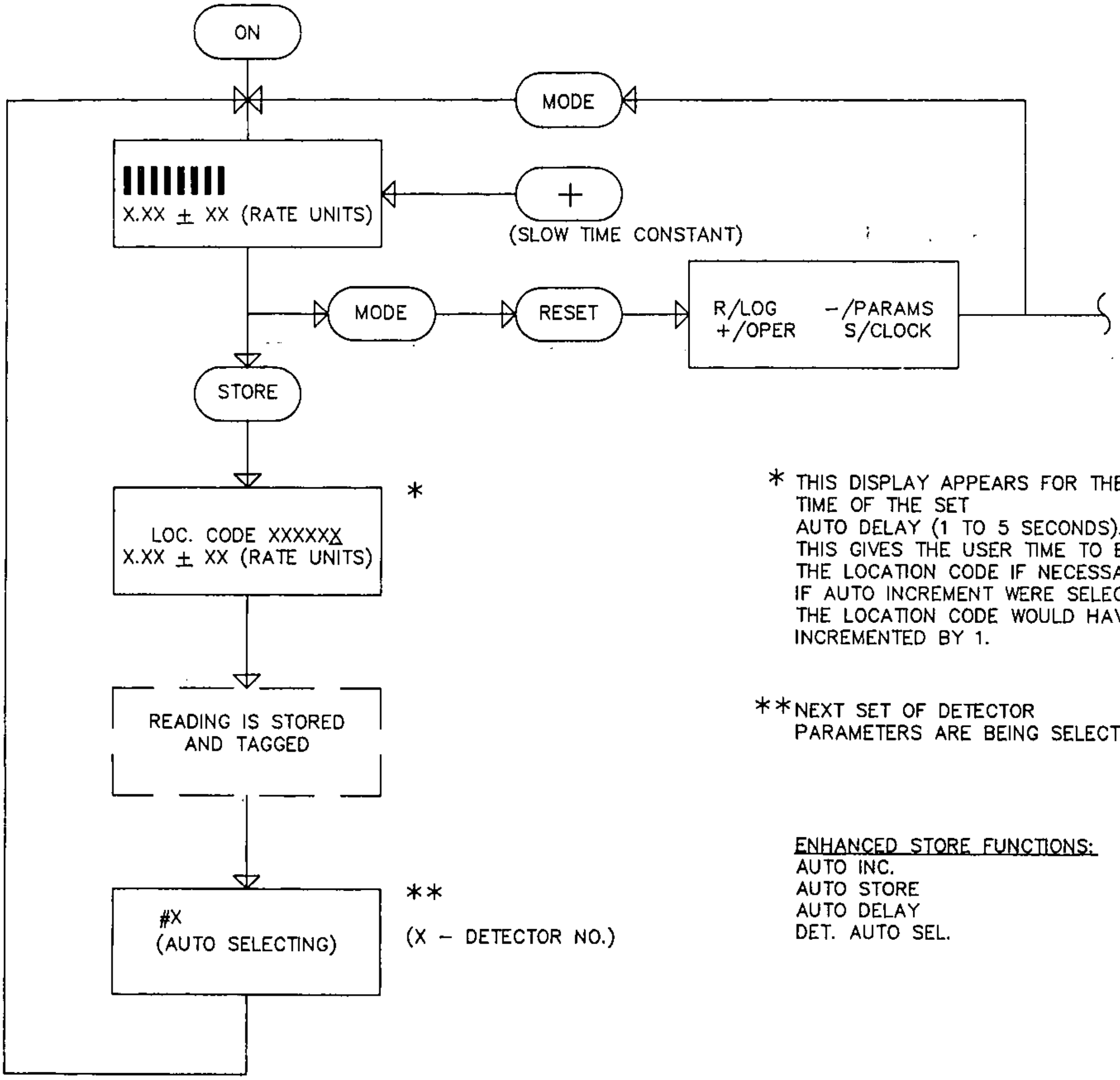

SEE FIGURE 3–10
INSTR. # XXXXXX "RESET" TO CHANGE
ENHANCED "STORE" "RESET" TO CHANGE
DEFAULT "STORE" "RESET" TO CHANGE
AUTO INC. LOC. "RESET" TO CHANGE
MANUAL INC. LOC. "RESET" TO CHANGE
MANUAL "STORE" "RESET" TO CHANGE
AUTO STORE "RESET" TO CHANGE
AUTO PAUSE X "RESET" TO CHANGE
(SECS)
1
2
3
4
5
DET. SELECT OFF "RESET" TO CHANGE
MANUAL DET. SEL. "RESET" TO CHANGE
2 DET. AUTO SEL. "RESET" TO CHANGE
3 DET. AUTO SEL. "RESET" TO CHANGE
ACCESS LEVEL 4 "RESET" TO CHANGE
SEE FIGURE 3–10
RESET
+
–

Figure 3-16, Selecting Enhanced Store Functions, 11383-C27

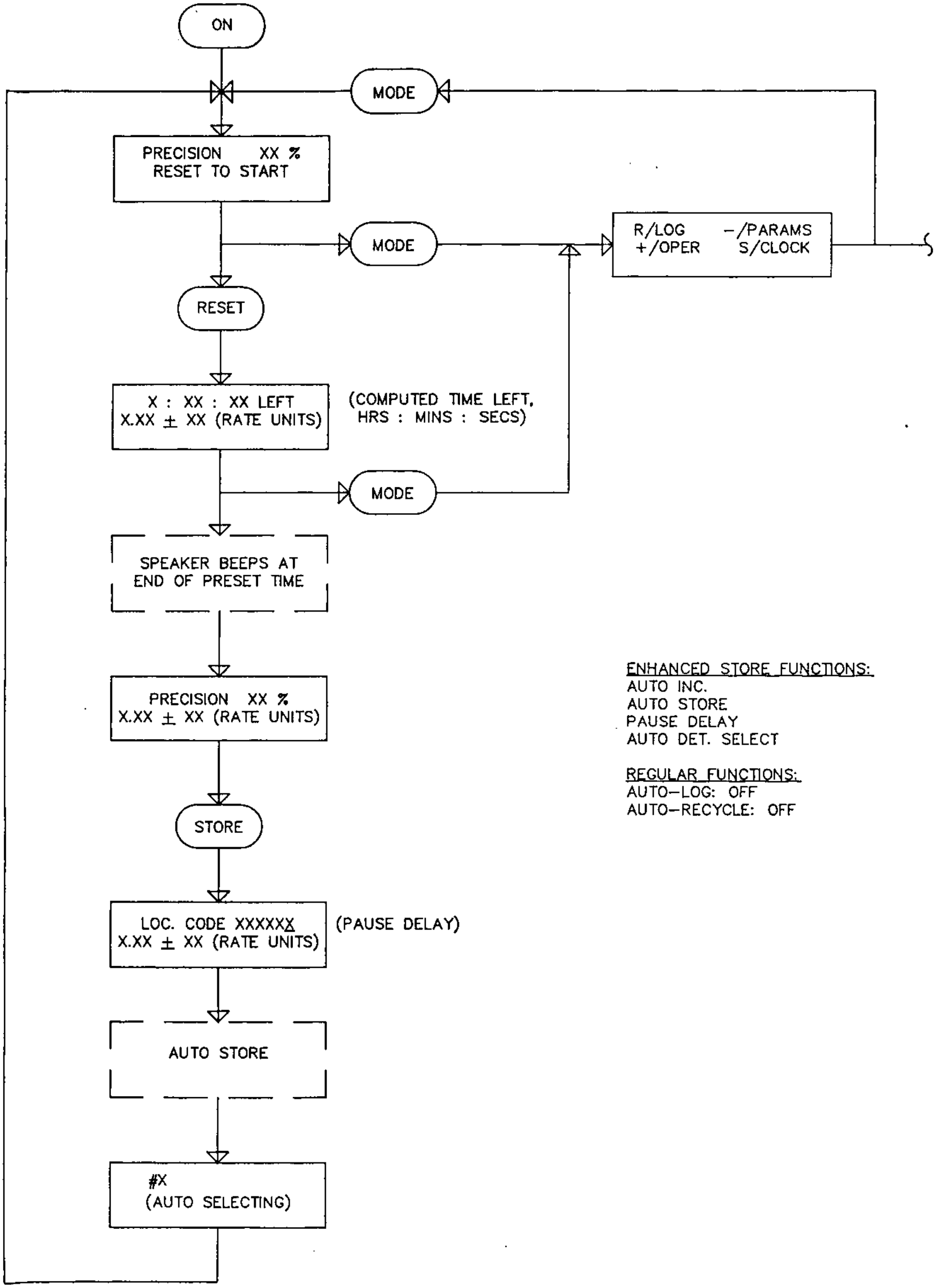


* THIS DISPLAY APPEARS FOR THE TIME OF THE SET AUTO DELAY (1 TO 5 SECONDS). THIS GIVES THE USER TIME TO EDIT THE LOCATION CODE IF NECESSARY. IF AUTO INCREMENT WERE SELECTED, THE LOCATION CODE WOULD HAVE BEE INCREMENTED BY 1.

**NEXT SET OF DETECTOR PARAMETERS ARE BEING SELECTED.

ENHANCED STORE FUNCTIONS:
AUTO INC.
AUTO STORE
AUTO DELAY
DET. AUTO SEL.

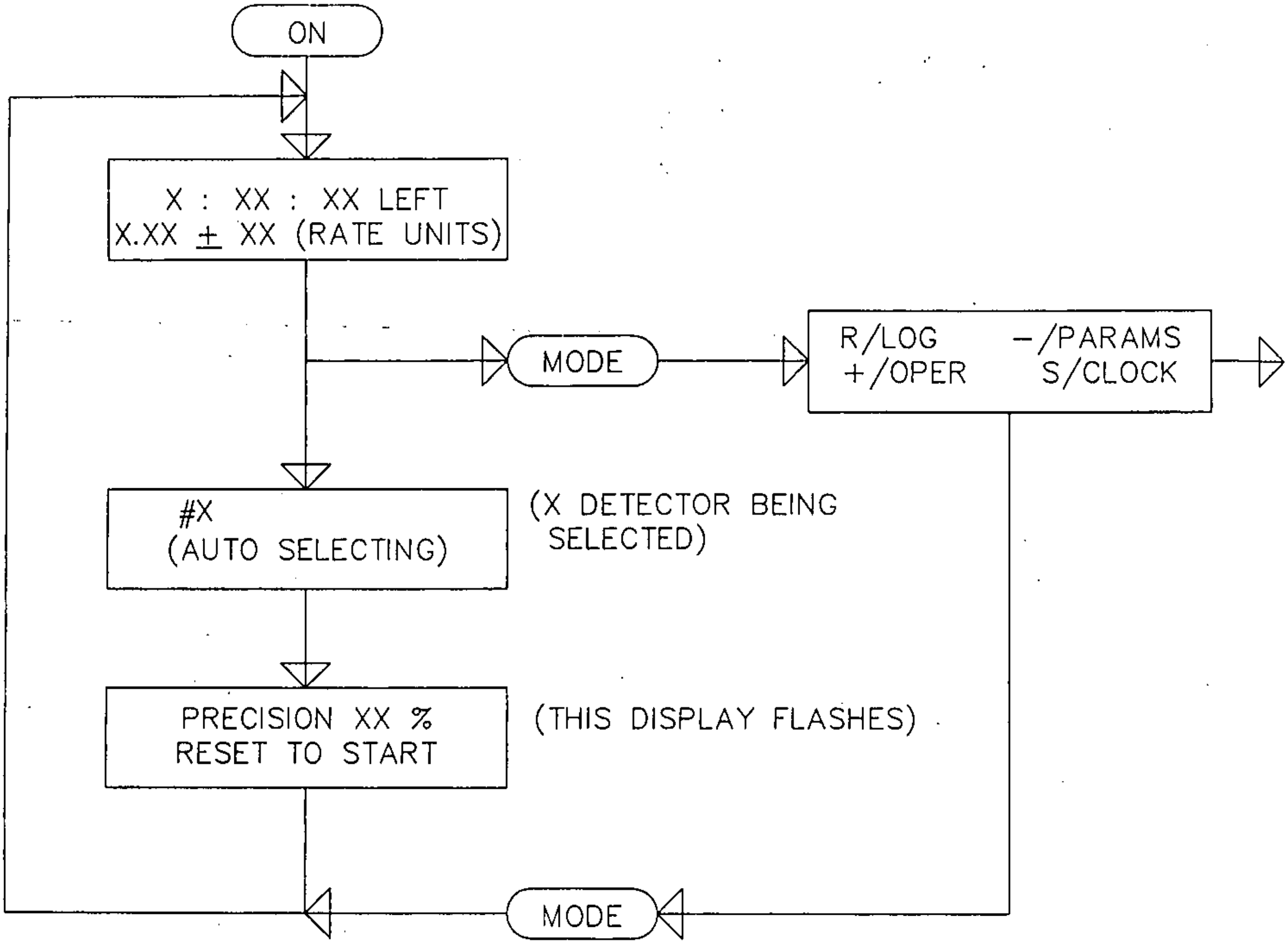
Figure 3-17, Ratemeter Mode with Enhanced Store Functions, 11383-C28



ENHANCED STORE FUNCTIONS:
AUTO INC.
AUTO STORE
PAUSE DELAY
AUTO DET. SELECT

REGULAR FUNCTIONS:
AUTO-LOG: OFF
AUTO-RECYCLE: OFF

Figure 3-18, Fixed Precision Scaler Mode with Enhanced Store Functions, 11383-C29



ENHANCED STORE FUNCTIONS:
AUTO INC.
AUTO STORE
PAUSE DELAY

REGULAR FUNCTIONS:
AUTO–LOG: ON
AUTO–RECYCLE: ON

Figure 3-19, Fixed Precision Scaler Mode with Enhanced Store Functions, Auto-Log, and Auto-recyle, 11383-C30

Section 4

SECTION IV. THEORY OF OPERATION

A. GENERAL

The SRM-200 employs current technology to provide to the user a compact instrument that can be used to measure and log data from several kinds of radiation as detected by different detectors. In addition, the SRM-200 is line powered, backed by a rechargeable battery in case the line voltage is not available. Many other features are available with the SRM-200. The following sections describes the functional and operational features of the SRM-200.

B. FUNCTIONAL THEORY

The SRM-200 consists of nine functional sections as detailed below (see Figures 7-1, 7-2, 7-3).

1. Detector

The detector connected to the SRM-200 is selected to optimize its output for the radiation of interest. It provides the pulse signal to the electronics for counting. The pulse rate from the detector is proportional to the radiation field intensity at the detector.

2. High Voltage Supply

The high voltage supply provides the bias voltage to the detector as required for proper operation. The high voltage is keyboard adjustable to provide the correct operating voltages for a large selection of detectors. It has good regulated operating stability and may be used with the pulse height analyzer (PHA) option.

3. Amplifier/Discriminator

The amplifier is a linear, adjustable gain, multistage design. It amplifies the signal from the probe to a usable level at the amplifier output. The discriminator provides a signal on its output only if the signal from the amplifier exceeds its adjustable threshold. This, in turn, provides a means for counting only radiation signal and to reject noise and/or unwanted signal.

4. Speaker/Alarm

The speaker/alarm section provides an audible "click rate" from the speaker, which is proportional to the output of the amplifier/discriminator. This rate can be scaled down to enhance the usefulness of the speaker when high-count rate (very sensitive) detectors are employed. When the alarm is activated, the speaker emits a continuous 2000 Hz tone.

5. Microcomputer

The microcomputer is an eight-bit device programmed to function as the interface between the SRM-200 operator and the information provided by the radiation detector (probe). Its program logic and speed of execution allow the SRM-200 to be extremely versatile by applying mathematical functions and logic to its input signals and displaying the results to the operator in an understandable format.

6. Low Voltage Supply

The low voltage supply regulates and provides the control point for the operating voltage for the SRM-200 electronics.

7. DC Power Supply

The DC power supply converts line voltage (115 Vac or 230 Vac, switch selectable) to DC voltage. This DC voltage trickle charges a rechargeable battery which supplies power to the instrument when the AC line cord is not plugged in.

8. RS-232 Driver

The RS-232 driver is a one chip device designed to generate its own ±10 Vdc supply from +5 Vdc and to provide four buffers, two for input and two for output. It interfaces the serial input and output bus of the microcomputer with an external peripheral device such as a printer or computer.

9. Clock Circuit

The clock circuit is a one chip device that interfaces directly with the microcomputer. It is crystal controlled and provides month, year, day, and time of day information to the computer. Date and time are setable from the keypad. The date-time information is appended to the data stored in the memory log.

C. OPERATIONAL THEORY

For the discussion that follows, please refer to Figure 7-1 through 7-13.

1. DC Power Supply

The AC line voltage is stepped down by transformer T, rectified by A and then filtered by C1. Voltage regulator A output is adjusted by R2 to provide the proper voltage for charging the internal battery and supplying power to the low voltage supply on the Amp/HV/Computer board set. The voltage out of the regulator is also dropped by resistor R3 then applied to the "AC ON" LED indicating that AC power is on and the battery is being charged. Diode Crt isolates the battery voltage from the voltage regulator output. AC power is applied (see Section V, Maintenance for proper setting of DC Power Supply output).

2. Low Voltage Power Supply

Computer voltage (V_c) is always applied to the computer to maintain its random access memory (RAM). With the SRM-200 off, battery drain consists of the normal leakage current of CMOS, typically less than 200 microamperes. During battery changeout, capacitor C28 (0.047 F) provides power for RAM for about 20 minutes (instrument off). This power maintains all the operating parameters at the values entered during calibration.

Pressing the "ON/OFF" keypad causes the microcomputer to initialize the program.

If the SRM-200 is operating when the keypad is pressed, it sets "PWR ON" of A108, HI (+5 V), turning off the low voltage (Q6, Q7, Q8) to all electronics except the microcomputer and its program access. This powers down or turns off A111, A109, A110 on the ESP basic printed circuit board, and A1, A2, A3, A4, A5, and A6 on the SRM-200 printed circuit board.

If the SRM-200 is off when the ON/OFF keypad is pressed, it sets "PWR ON" LOW (0.0 Volts) turning Q6 on. This supplies the operating voltage (+V) to the amplifier, high voltage control, display, speaker circuitry and RS-232 buffer circuits. It also switches on the battery voltage (V_{BB}) to the HV oscillator and battery sense via Q7, and Q8. (All circuits are now energized.)

3. Operation on Battery Backup

The SRM-200 is primarily intended to be used as an AC line powered instrument. An internal, rechargeable battery is provided for operation during an AC power failure or those times when the instrument must be operated away from an AC line. When operating the instrument from the internal battery only, the SRM-200 will monitor and sense a low battery condition.

Battery condition is monitored by one of the comparators in A101. Pin 15 is connected to the regulated reference (amplifier "bias"). When the voltage at pin 14 falls below this reference, the output (pin 16) goes low. This voltage transition is input to the microcomputer, causing it to initiate blinking of the first character on the LCD. The blinking indicates a low battery condition to the operator. This switch point occurs when the battery output is approximately 5.9 volts and allows the instrument to operate properly for about another four hours or until the battery voltage reaches its minimum. To recharge simply apply AC power to the SRM-200.

4. High Voltage Power Supply

High voltage is obtained by stepping up (T1) the voltage of the oscillator (Q2), doubling it (CR3, CR2, C3, and C4), rectifying it (CR1) and filtering the output (C1, C2, R3). High voltage is regulated by feeding back the output to control the oscillator.

At turn-on, Q8 is on, causing Q2 to turn on. Current flow through T1 (pins 2, 3) feeds back via T1 (pins 4, 5) turning off (blocking) Q2. With Q2 off, blocking stops and Q2 turns on. This is a blocking oscillator, the frequency of which is limited by (C25, C9, R12) maintaining best efficiency of T1.

The high voltage output is fed back via resistive divider R1 and filter C7 to a voltage follower, A100 pin 3. This stage, with a high input impedance, allows R1 to be large, presenting a minimal current load for the supply. The output of the voltage follower is then proportional to the high voltage output. Because the input impedance to this stage is high, C7 provides filtering to reduce noise interference.

The filtered high voltage sample is input to a op amp (A100, pin 15) that is referenced to the high voltage adjusting reference amplifier (A100). When the sample (pin 15) exceeds the reference (pin 14), the output at pin 16 goes low, reducing the voltage to Q1, which partially turns off the oscillator, reducing high voltage. As the sample decreases to less than the reference, pin 16 goes high, turning Q1 more on. The oscillator then runs harder to increase the high voltage. In this way, the high voltage is regulated to a value set by the HV reference amplifier (A100).

The filtered output of the high voltage sample is also applied to pin 5 of A100. This stage is connected with A100, R13, and R14 to achieve a HV indication level for the computer. If the voltage at pin 5 is lower then the voltage at pin 6, the output at pin 7 goes low and indicates to the computer that HV has failed.

A100, an op amp, is used in conjunction with A112, a D/A converter, to establish digital control of the high voltage reference. The D/A, A112, contains two symmetrical ladder networks each of which outputs across R72 and R73 separately. A110, R68, R69, R70, R71, R67, R66 form a differential amplifier. The gain is controlled by R66 and the output level is controlled by R68. R66 and R68 must be adjusted together to calibrate the high voltage. The high voltage is calibrated when the value measured by an accurate, very high impedance high voltage meter matches the instruments displayed value. R11 and C6 form an RC filter for the high voltage reference.

5. Amplifier/Discriminator

Transistor Q3 and the amplifier section of A101 form a dc-coupled linear amplifier. The gain of this amplifier is set by R20 and the output impedance of the preamplifier (Q3) along with R21-R22 and the gain of the preamplifier stage. Feedback via R19 provides dc stability. The dc bias is set by R23-R24 to half of +V (~2.5 volts) for a linear swing of signal on the amplifier outputs. Input protection is provided by CR4-R15, which give a charge path for input capacitor C11 when high voltage is shorted.

The amplifier output signal is coupled to the Discriminator (A101, pin 11) with capacitor C15. An output (A101, pin 10) occurs when the amplitude of the signal (pulse exceeds the reference (A101, pin 12) set by the threshold potentiometer (R27).

The Discriminator output is divided down by 2, (A105), yielding a binary input for the microcomputer. The microcomputer counts the binary transitions and calculates and displays the result as either rate or integrated value for the operator.

6. Alarm Relay Contacts

The SRM-200 provides alarm output contacts on the rear panel of the instrument. They are labeled; C - common, NO - normally open and NC - normally closed. When there is no alarm condition, continuity exists between the C (common) and NC (normally closed) contacts. Likewise, the C (common) and NO (normally open) contacts have no continuity between them. However, during an alarm condition they reverse states. The C (common) and NO (normally open) contacts will have continuity, while the C (common) and NC (normally closed) contacts will not.

When an alarm occurs, besides energizing the relay, the Alarm LED will light. If the internal SPKR switch is "on", a 2000 Hz tone will be emitted from the speaker. Pressing the SPKR switch will acknowledge the alarm. This results not only in the alarm light and audible tone being turned off, but also resets the relay contacts to their normal state. The alarm will remain off until the reading has dropped below the alarm setting and then exceeds it again. If the alarm is never acknowledged, it will remain on as long as the reading exceeds the alarm setting.

7. Speaker

Pulses that cause an output from the discriminator are input to the speaker control either directly or counted down for slower audible rate. In either case, the rate from the speaker is proportional to the radiation level at the detector (probe). The speaker is enabled or disabled by the microcomputer when the operator presses the "SPKR" keypad. The speaker is enabled when "SPKR" is low (0 volt).

One half of A102 is interconnected as a monostable multivibrator (TRIGGER). The output pulse (TRIGGER) width is set by R54-C18 time constant. The other half of A102 is configured as an oscillator. It is running while the trigger output (pin 11) is low, driving the speaker via Q4 and Q5. The input signal to the trigger is differentiated by C20-R46 to prevent excessive trigger pulse widths.

The alarm is activated by "ALM" and "SPKR" set low (0 volts) by the microcomputer. This sets the trigger output low (pin 11), turning on the oscillator frequency to the speaker.

"ALM" low also activates the auxiliary alarm (ALARM, Q10) providing an active low output for external indication (250 mA, 20 Vdc maximum).

8. Keyboard

The switch poles are etched on the PC board. Contact between the poles is made by a conductive pad cast into each keypad. Pressing a keypad effectively short-circuits the poles.

The ON/OFF keypad pulls the RST (pin 9) of the microcomputer high. This causes the computer to reset itself and begin running its program at the program beginning.

All other keypads are inputs to the microcomputer via its input/output (I/O) port P1, which is configured as an input port under program control. These inputs are normally high. Pressing a keypad pulls the corresponding port input low.

The program running in the microcomputer performs the contact debounce, determines the switch (or switches) pressed, and logically performs the task(s) associated with the keyboard condition.

9. Microcomputer

Simply stated, a computer must have provisions for moving data in and out (I/O), a logical means of handling and saving data (memory), and logical elements to control I/0 and memory (central processing unit-CPU). To perform any task, the CPU must execute a series of logical steps (program), which is contained in read-only memory (ROM). Memory used to save data written to or read from it is random access memory (RAM). The RAM contains the parameters (variables), logic flags, data, scratch pads, etc. used by the program.

a. Inputs:

1) Keyboard inputs are the operator's input to the computer. Under program control, the inputs cause the task associated with the keypad(s) to be performed (see Section II.A.6.).

2) Received Data (RXD) input is the serial data input port. Serial data emanating at an external computer or peripheral device is received at A8 (RS-232 buffer) and passed on to this input.

3) HV IND is active high and indicates to the computer that high voltage is present. If high voltage has failed or shorted HV IND goes low and signals to the computer that HV has failed.

4) Lo Batt (low battery) input (normally high) switches low when the low battery condition is sensed (see Low Voltage above). This causes the program to blink the first character on the display at each display update (output), warning the operator of the low battery condition.

5) CNT (count) input is a signal the rate of which is proportional to the radiation intensity at the detector. The rate is calculated by the program (counts/time). The calibration constant (CC) and correction factor (CF [based on detector dead time]) result in a value in radiation units as calibrated. The results are then output to the display for the operator.

b. Outputs:

1) "PWR ON" (Power on, active low) is output under program control to turn the power to the instrument on or off (see Low Voltage Supply above).

2) "SPKR" (Speaker on, active low) is output under program control when the SPKR keypad is pressed. The output is complemented at each press of the keypad. This results in a push-on/push-off action of the SPKR keypad (see Speaker above).

3) "ALM" (Alarm output, active low) is output-activated when the program has sensed that the calculated reading has exceeded the value input by the operator for ALM AT (alarm setting). SPKR output is also activated to turn the speaker on (see Speaker above).

4) "DTR" (Data Terminal Ready, active high) is transmitted to a peripheral device via the RS-232 buffer A8. This signals to the peripheral device that the computer desires to send it serial data.

5) "TXD" (Transmitted Data) is 8 bit per character, 2 stop bits, no parity serial ASCII data which is transmitted to a peripheral device via the RS-232 buffer A8.

6) The display is a liquid crystal (LCD) 5 x 7 dot matrix character, 2 lines of 16 characters per line. This allows the full alphanumeric ASCII character set as well as the special characters used to display the analog barograph. The LCD is a "smart" display in that it is supported by its own microprocessor and program, thus relieving the computer of this processing load.

The computer outputs to the LCD command instructions and data to be displayed based on the tasks being performed. These data/commands are passed to the display via the 8-bit address-data bus (A108, Port P0). A command (instruction) is differentiated from data (character to display) by address line 8 (A108, pin 21), high equals command. The command/data are accepted by the LCD when "WR"

(A108, pin 16) is low simultaneously with decoder A109, pin 9 being low. This causes the LCD "E" (enable) pin 6 to be strobed.
The viewing angle of the display is set permanently by connecting V_o input (pin 3) to ground thru R47.

The display is not considered to be field repairable.

7) The D/A converter, A112, is input from the computer via the P0 (AD0 to AD7) bus lines. This D/A outputs to a differential amplifier A100 and together the pair form a digitally controlled high voltage supply reference. 00H creates the reference for minimum high voltage output (500 Vdc) while FFH creates the reference for maximum high voltage output (2,450 Vdc). A112 is selected by the computer by output of the decoder A109, pin 7.

8) The clock A6 is connected directly to four bus lines on P0 (AD0-AD3). The 4 bit I/O data at A6 pins 11, 12, 13, 14 is addressable via pins 4, 5, 6, and 7. The data provides seconds, minutes, hours, day of week, date, month, and year. Data access is controlled by 4-bit address, chip selects (pins 15, 2). WR (pin 10), RD (pin 8), and ALE (pin 3). Data can be written to or read from the clock. The clock contains its own oscillator and an external 32.768 KHz (X1) crystal oscillator.

9) Decoders A109 and A5 decodes bits A12 thru A15, from P2 to select one among several devices the CPU interacts with. Devices that are selected through the decoder on ESP-2 PC board (A5) are the Clock (A6), the Input Port (A4), RAM (A3), and EPROM (A2). Decode line A12 selects between the Input Port A4 and the Clock (A6). Devices that are selected through the decoder on the ESP-1 basic PC board are the display and the D/A converter (A112). EPROM A111 is selected via data line A15 from the buffer A110.

c. Memory and CPU:

RAM registers are contained in the RAM chip (A3) and within the microcomputer chip. The timers are also contained within the microcomputer chip. Their functions are solely to control the program (i.e., program counter and stack pointer) or for use by the program to perform its tasks (RAM and ALU).

Port P0, A108, is the address-data bus. It is bi-directional (input and output). Port P2, A108, outputs the upper eight bits of the address. On a typical program step:

1) The address program counter is output at P0 (low byte) and P2 (high byte).

2) "ALE" (address latch enable) is asserted and latches the address low byte in A111 and A1.

3) "PSEN" (program store enable) is asserted enabling the addressed byte to be input to the computer via P0.

4) The program step is executed.

The program is stored in A111 and A2. The socket for A111 is wired such that an 87C256 EPROM (when available) can be adapted providing up to 32K program memory. In this case jumper r to s is cut and a jumper wire added between s and t. A2 space then can become available for more RAM with proper connections of jumpers on pins 22 and 27 of A2.

d. RS-232 Buffer:

A8 is a RS-232 chip which contains its own power supply for converting from +5 Vdc to ±10 Vdc which is used for RS-232 serial data transmission. C7, C8, C9, C10 are capacitors which are used in creating the ±10 Vdc supplies. A8 contains four buffers, two for receiving and two for transmitting. The two transmit buffers convert the logic level from TTL to ±10 V level whereas the two receive buffers convert the ±10 V logic levels to TTL.

e. Input Port:

A4 is an input port buffer. It takes the Data Set Ready (DSR) signal from A8, pin 9 and inserts it on the CPU P0 bus line. Provisions are made for inputs of future applications on pins 4, 6, 10, 12, and 14. Resistor array R3 are pull down resistors for all inputs to reduce instrument off current thru A4.

10. Optional PHA Circuit

When the pulse height analyzer (PHA) board is installed, the shorting header is omitted. A voltage divider from the +5 volt line is formed by R28, R33, R32 (window), R27 (threshold) and R31. Each of the 5 resistors has 10K ohms so each resistor has a nominal one volt drop across it. The upper two comparators shown in A106 are the threshold and window comparators. The threshold comparator reference (A106 pin 7) is held at 2 volts and the pulse driven input (A106 pin 6) is dc biased between 1 and 2 volts by the threshold control. Any positive pulse large enough to take pin 6 to 2 volts has crossed the "threshold".

The reference input of the window comparator, A106 pin 5 is adjusted by the window control between 2 and 3 volts. This reference is the "top" of the "window". The pulse driven input (A106 pin 4) is tied directly to the pulse input pin of the threshold comparator and so it too is dc biased between 1 and 2 volts by the threshold control. Any pulse that drives the two input pins up to 2 volts has crossed the "threshold" and has entered the "window" area. If the top of the pulse stays in the window, that is, does not reach the window reference voltage at A106 pin 5, then it is an "acceptable" pulse and will be counted. If the pulse is so large that it exceeds the window reference voltage at A106 pin 5, then it is has gone out of the "top" of the "window" and it will not be counted. In this way, the PHA circuit may be set to accept only a small range of pulse amplitudes which may represent a specific radiation energy. Since the threshold crossover point is always at 2 volts and the window reference adjusts from 2 volts upward, the window width is independent of the threshold setting.

If the pulse height is "in the window," A106 pin 1, A106 pin 9 and A107 pin 1 (clock A) go low when the pulse crosses the threshold. When the pulse returns below the threshold, clock A goes high and the first binary in section A of A107 changes state since a positive transition at the clock input advances the counter. The binary output at A107 pin 3 goes high and this signal is carried to the comparator input at A101 pin 11. A101 pin 10 goes low and A105 registers the count. The high at A107 pin 3 is carried to reset pin A107 pin 7 by CR32 and the binary stage is reset to zero, causing A107 pin 3 to return to a low output.

If the pulse height is above the window, A106 pin 1, A106 pin 9 and A107 pin 1 go low as before when the pulse first crosses the threshold. When A106 pin 9 goes low, A106 pin 14 also goes low and C32 is discharged through CR31. When the pulse continues upward out of the window, A106 pin 2 goes low and if S31 (PHA-GROSS switch) is closed, A107 pin 9 (clock B) also goes low. When the pulse amplitude comes back into the window on the way down, A106 pin 2 and A107 pin 9 return high and the first binary of section B of A107 changes state. (Positive clock transition). Pin A107 pin 11 immediately goes high and CR33 holds section A in the reset condition. When the pulse falls below the threshold, A106 pin 1, A106 pin 9 and A107 pin 1 return high. Section A of A107 does not change state because of the reset signal through CR33. As A106 pin 9 goes high, A106 pin 14 goes high, coupling the high through C32 to pin 11. This causes A106 pin 13 to also go high, resetting section B of A107 which removes the reset signal of section A. A106 pin 13 and B reset return low when R39 recharges C32 and A106 pin 11 goes low. The circuit is now ready for the next pulse.

If the PHA-GROSS switch is in the GROSS position (open), A107 section B cannot hold section A in reset and all pulses above the threshold will be counted.

Section 5

SECTION V. MAINTENANCE

A. CALIBRATION

1. General

The SRM-200 is an extremely versatile instrument. It is usable with a wide variety of detectors and can be calibrated in a large variety of radiation units. The end result of the calibration process is the reading provided by the instrument. The accuracy of that reading depends on the accuracy achieved in the calibration process.

Properly set up and calibrated, the instrument is inherently linear and accurate because of its microcomputer based design. The only real limitation is the detector and its application in a particular measurement. For detector application information, see Section VIII.

The calibration procedure should include testing for instrument/detector quality (plateau) as well as adjusting the reading to the radiation field at the detector. A recommended procedure follows:

NOTE

To change the parameters that calibrate the SRM-200, the instrument must be set for access level 4. (See Table 2-1.)

2. DC Power Supply

The DC power supply should be adjusted to provide the proper charging voltage to the gel-type battery. To accomplish this, first remove J2 (4 pin connector) from the power supply board. Then disconnect the two battery leads and place a 130 ohm, 1/2 W resistor across the. With AC power applied adjust the "LV ADJ" (R2) potentiometer for 6.83V across the battery leads. Remove AC power and reconnect battery leads and J2.

3. High Voltage

The high voltage readout, which can be viewed in the Parameters Mode, is a computer generated number which is not only displayed, but is supplied to a D/A converter which generates the reference voltage for high voltage supply. The readout must be calibrated to equal the actual high voltage. In order to do this, connect a voltmeter to the detector connector. The input impedance of the voltmeter must be 1000 megohms or greater. Display the high voltage reading in the Parameters Mode and using the RESET and "+" or "-" as required, adjust the display to read HV = 6.07 + 2.

Remove the bottom cover (see Section V.C.3.). Adjust internal potentiometer R68, HV level, until the measured voltage is 607 Vdc. Now adjust the high voltage reading on the display to read HV = 1.80 + 3. Adjust internal potentiometer R66, HV GAIN, until the measured voltage is 1800 Vdc. Now adjust the high voltage reading on the display to read HV = 6.07 + 2. Then again adjust R68, HV level, until the measured voltage is 607 Vdc. Readjust the high voltage reading on the display to read HV = 1.80 + 3 and the adjust

R66, HV GAIN until the output measures 1800 Vdc. Repeat this procedure back and forth until the measured readings converge to the ones read on the display.

The instrument is shipped with the high voltage calibrated.

4. Instrument/Detector Quality

The overall gain of the instrument is adjustable with the detector bias (High Voltage), R22 GAIN potentiometer, and the discriminator setting (R27, THRESHOLD potentiometer). The gain should be adjusted for the maximum detector efficiency that also provides the best stability for the measurement. Usually R22 is adjusted full CW for maximum amplifier gain.

The discriminator setting (threshold input sensitivity) is set based on the detector type to be used (see Table 5-1) and may be set by either of the following methods. The pulse generator method is preferred.

a. Pulse Generator (Eberline MP-1 or MP-2 recommended).

Connect a pulse generator with a calibrated pulse amplitude output to the SRM-200 detector connector. Set the SRM-200 input sensitivity as recommended in Table 5-1, by adjusting the R27, THRESHOLD control until the instrument is just reading the pulse generator with its amplitude set to the value in Table 5-1. (See Figure 2-2).

b. Voltmeter (20K ohms/volt minimum)

Measure the voltage on "TEST" connector, pin 9. Adjust the R27, THRESHOLD control for a voltmeter reading corresponding to the proper input sensitivity referenced in Tables 5-1 and 5-2. Make sure the GAIN control R22, is fully clockwise.

WARNING

The high voltage should be set to the "Nominal Operating Voltage" or less (reference Section VIII) before connecting the detector to the SRM-200, to prevent damage to the detector. Check the high voltage by selecting the "HV =" parameters on the display while in the Parameters Mode. Make sure high voltage calibration has been performed.

DETECTOR MODEL	HIGH VOLTAGE	INPUT SENSITIVITY	UNITS	NOMINAL VALUES*****		CALIBRATION FIELDS	
				"CC="	"DT(SEC)"	SET "CC" AT:	SET "DT" AT:
AC-3-7	1000V**	10 mV	cpm	2.80-01***	1.20-05	30K cpm	2.5M cpm
AC-3-8	1000V**	10 mV	cpm	1.80-01***	1.20-05	30K cpm	2.5M cpm
HP-100A	1550V**	1.75 mV	cpm	******	******	******	******
HP-210,260	900V	10 mV	cpm	1.00+00*	7.50-05	72K cpm (≈20 mR/h)▮	2700K cpm (≈750 mR/h)
HP-190A	900V	10 mV	cpm	1.00+00*	3.00-04	50K cpm (≈20 mR/h)▮	500K cpm (≈200 mR/h)▮
HP-220A	550V	10 mV	R/h	1.55+06	7.60-05	500 mR/h	200 R/h
HP-270	900V	10 mV	mR/h	7.00+07	1.20-04	20 mR/h	1.0 R/h
HP-290	550V	10 mV	R/h	5.00+06	2.00-05	500 mR/h	25 R/h
HP-230A	900V	10 mV	cpm	1.00+00*	1.67-04	60K cpm (≈20 mR/h)▮	1800K cpm (≈600 mR/h)▮
LEG-1, PG-2	1000V**	10 mV	cpm	1.00+00	1.20-05	50K cpm	3000K cpm
NRD	1850V****	2 mV	mREM/h	3.00+06	1.00-05	27 mREM/h (≈1200 cpm)	fixed value
SAC-R5	800V**	10 mV	cpm	******	******	******	******
SPA-1A	650V**	10 mV	dpm	5.00-01***	1.00-05	10K cpm	fixed value
SPA-3	1000V**	10 mV	cpm	1.00+00	1.40-05	700K cpm	3000K cpm
SPA-6	1000V**	10 mV	cpm	1.00+00	1.20-05	50K cpm	3000K cpm
SPA-8	700V**	10 mV	cpm	1.00+00	3.50-05	fixed value	7.5 mR/h (≈1.0 x 10^6 cpm)
SPA-9	1000V**	10 mV	cpm	1.00+00	1.85-05	fixed value	5.0 mR/h (≈2.5 x 10^6 cpm)
WAM-4	1000V**	8 mV	dps	1.76-01	1.30-05	30K cpm	fixed value
RCM-1	1200V**	5 mV	dps	2.80-01	1.30-05	60K cpm	fixed value

*These are the values to be used when the instrument is set up to read in units of cpm. Other values must be used for "CC" if you wish to set your instrument to read in 2π cpm or 4π dpm alpha or beta efficiency.

**Detector high voltage should be set after running detector plateau.

***Set to the efficiency value determined from plateau (e.g., if 31 percent efficient, then CC = 3.10-01). If calibration is to true detector counts, "CC" should be set to 1.00 after "DT" adjustment has been performed.

**** HV setting depends on gamma rejection point. Determine by placing NRD in 10 R/h gamma field (or desired gamma field to be rejected) and adjust HV for approximately 50 cpm. Reduce HV by 50 V and verify no counts in the 10 R/h field. The HV set point is now established, and should not exceed 2200 V.

*****These nominal values may be used to set up the instrument; (1) if the calibration sheet (which has the exact values) for the instrument with the specific detector is not available; or (2) if the user wishes to use a detector which was not purchased with the instrument. Please note that the use of nominal values constitutes a generic rather than a specific calibration and, therefore, will be less accurate as compared to using values from the calibration sheet.

******The instrument is operated in the scaler mode, counts/min. The CC is set to 1.00+00 and the DT is set to 1.00-06 (fixed values).

▮ Approximate values in mR/h are based on Cs-137 photons.

Table 5-2. Input Sensitivity vs. Threshold Voltage

Input Sensitivity (mV)	Vthld* (volts)
1.0	0.072
2.0	0.220
5.0	0.662
10.0	1.45
15.0	2.18

*Test connector, pin 9.

c. Connect the detector to the SRM-200. With R27, THRESHOLD potentiometer properly set, the plateau curve can be plotted. This is the only data that can truly verify that the detector and instrument are operating properly and, with the possible exception of G-M detectors, and should be plotted anytime a detector is changed or repaired.

The bias (High Voltage) operating point for a G-M detector is fixed by its physical properties (i.e., size, counting gas, anode size, and fill pressure). Therefore a check of its sensitivity, or efficiency, may preclude the plateau. It should be within ±20 percent of specified sensitivity at the specified operating voltage (see Section VIII).

To plot the plateau (Figure 5-1):

1) Select the "HV=" parameters on the display (Parameters Mode). The second line of the display shows the current average rate from the detector.

2) Adjust the "HV" for a low reading from the detector. Record the reading and the high voltage.

3) Increase "HV" in steps of 50 volts, recording the reading and high voltage at each step. Allow enough time at each step for the reading to stabilize.

4) Select the operating high voltage and adjust the "HV" control accordingly.

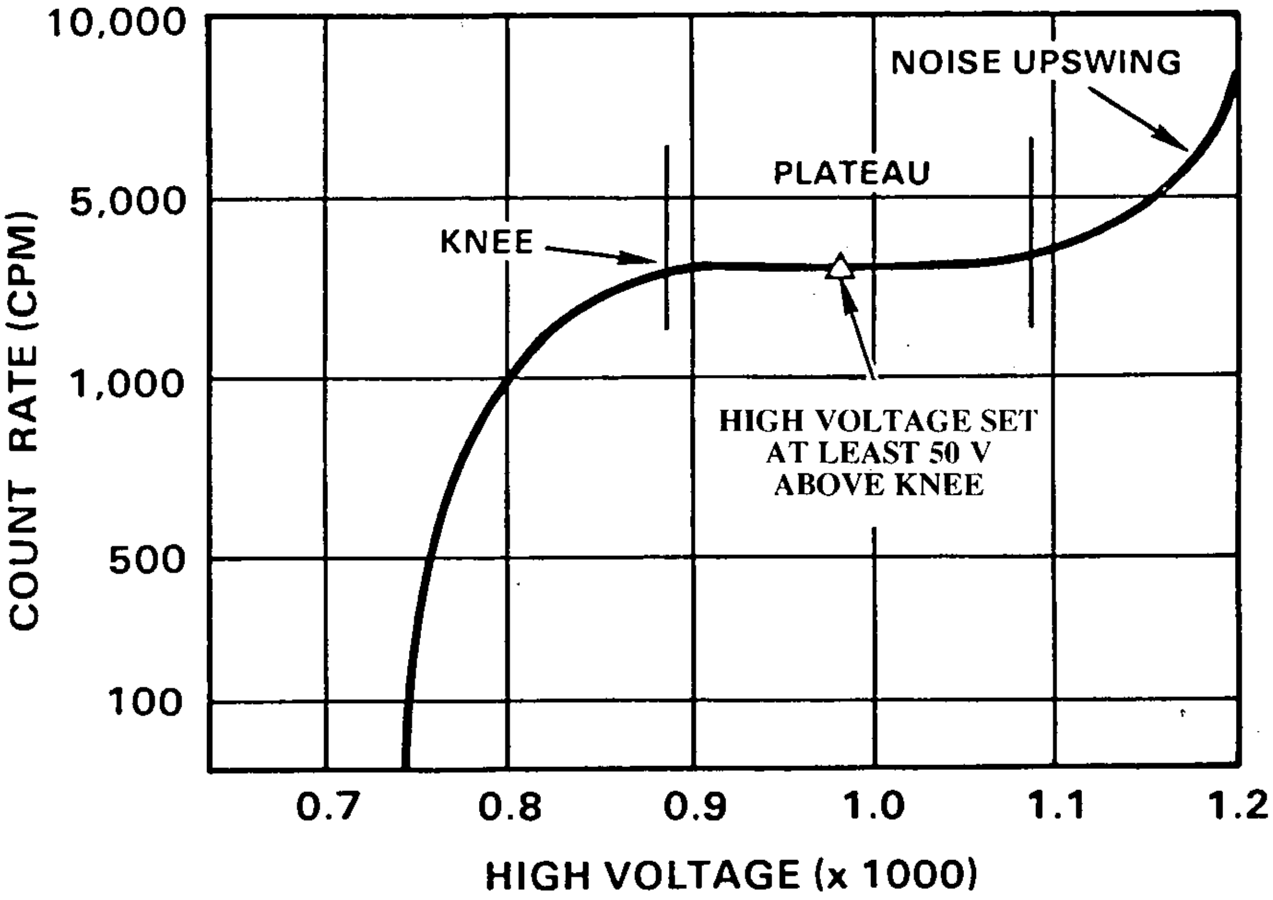


Figure 5-1, Typical Detector Plateau, 11383-A36

5. Ratemeter Calibration

For clarity, a brief overview of the readout determination follows:

a. The average count rate is calculated each 1/2 second. This average is maintained in counts per second (cnt/s) and is the basic unit for all readout displays. This average is also corrected for detector dead time (parameter "DT").

b. The average (AVG) is divided by the calibration constant (parameter "CC") (see Table 5-3) and the proper factors, specified in the units, prefix, and suffix are applied, converting the cnt/s to the radiation units selected. This is performed and displayed every 2.0 seconds.

The calibration is performed by adjusting the "CC" and "DT" values so that the ratemeter readout agrees with the radiation intensity at the detector.

Note that the dead time correction is applied to the average before "CC". At lower count rates, this correction is insignificant.

Refer to Table 5-1 for the following:

1) Set the instrument to Parameters Mode.

2) Set high voltage and input sensitivity to suggested values, for detector being calibrated.

3) Set "CC=" and "DT" equal to nominal values for detector being used. (Refer to Section III - Detailed Operation, if necessary.)

4) Select the "CC=" parameter. The current ratemeter reading is always displayed on the bottom line of the LCD (this applies to all parameters, DT, HV, etc.).

5) Expose the detector to the radiation field indicated under "set CC at" (Table 5-1), and adjust "CC=" until ratemeter reading matches the field strength. Note that increasing the value of CC will decrease the ratemeter reading, and decreasing CC will increase the ratemeter reading. See Table 5-3.

6) Select the "DT (SEC)" parameter. Expose the detector to the field indicated under "set DT at" (Table 5-1), and adjust DT until ratemeter reading matches the field strength.

7) Recheck reading taken in step 5. If not in agreement, repeat steps 5 and 6 until both readings are correct without having to vary the "CC" and "DT" parameters.

8) At this point no further adjustment is necessary. However, a few linearity readings at fields in between the CC and DT settings, would be an added verification of correct detector/instrument operation. Increasing the radiation field above the DT set point, will eventually cause an over-range alarm. This is useful in determining the upper range limit of that particular detector and instrument combination.

NOTE

The instrument may be rough-calibrated by adjusting nominal values in Table 5-1. For detectors which nominal values are not specified, the user may determine his own nominal values for ease and/or speed of the calibration process.

Table 5-3. Calculating Calibration Constant

CC = counts/base unit.

Example:

a. HP-270 sensitivity is 1200 cnt/min/mR/h (nominal).

b. Base unit selected is R.

CC = (1200 cnt/min/mR/h x 60 min/h) x 1000 mR/R

CC = 7.2 x 10^7 cnt/R

SPECIFIED PREFIX	PREFIX FACTOR (PF)	SPECIFIED SUFFIX	SUFFIX FACTOR (SF)
(none)	1	s (second)	1
μ (micro)	1 x 10^{-6}	min (minute)	0
m (milli)	1 x 10^{-3}	h (hour)	3600
K (kilo)	1 x 10^{+3}		
AUTO			

(AVG/CC) x SF x PF = READOUT IN RADIATION UNITS AS SPECIFIED.

NOTE

PF and SF are applied automatically as defined by the "units" selected and do not affect "CC".

B. CALIBRATION WITH PHA

To utilize the pulse-height analyzer (PHA) function, the amplitude of the detector pulses must be proportional to the energy of the radiation and must vary with the high voltage applied.

The installation of a PHA option is performed at the factory when the SRM-200 is purchased. To replace a PHA PC board perform the following: Turn off the SRM-200, unplug the AC, and remove the bottom case cover. Unsolder the PHA switch wires at the place where they are connected on the PHA PC board. Unsolder the window potentiometer wires at the PHA PC board. Note wire colors as you unsolder these wires, so you will later know where to replace them. Remove screw holding PHA PC board and remove PHA PC board. Replace with new PC board in reverse order.

The most reasonable readout units for PHA operation are counts per unit time (cpm, cps, etc.), since the detector is producing pulses from other energies which are not being counted. However, the PHA circuit operation is the same, regardless of the readout units chosen. A review of the PHA circuit description and terms used in the "Theory of Operation" section may be helpful. The adjustment of the window width, relative to the threshold setting, is always a compromise. The window width is expressed in percent of the window dial reading relative to the threshold dial reading. For example, if the window dial reading is 2 and the threshold dial reading is 5, then the window width is termed to be 2/5 x 100 = 40 percent or a 40 percent window. Refer to the curves of figure 5-2. In each case, the narrower window results in a sharper peak (better exclusion of adjacent energies), but the count rate is lower and the peak may be harder to find. Experimentation using the particular detector and a check source of the isotope of interest will help select the best percent window for your application. In general, a window between 25 percent to 100 percent of the threshold level is reasonable.

There are three adjustments which can effect the amplitude of the pulse at the point where it crosses the threshold. These are high voltage setting (adjustable from the keypad), amplifier gain pot, R22 (internal pot adjustment) and threshold potentiometer, R27 (external dial adjustment). Of the adjustments it is more convenient to first adjust the amplifier gain pot, R22, so that a 25 millivolt input pulse will just cross the threshold when the threshold dial is set at 10 (or maximum value). From then on the internal gain pot adjustment will not have to be readjusted. Thus, to set the instrument's sensitivity to a given mv pulse amplitude the following formula may be used:

$$\text{TDS} = \frac{\text{DIS}}{25 \text{ mv}} \times 10$$

TDS = Threshold Dial Setting

DIS = Desired Input Sensitivity (mv)

This formula is most useful when the PHA is not being used and the PHA switch is set to GROSS. When the PHA option is purchased with the SRM-200 the internal gain pot is factory adjusted for 25 millivolt input sensitivity when the threshold dial is set at 10. For instance, if DIS = 2.5 mv.

$$\text{TDS} = \frac{2.5}{25} \times 10 = 1$$

In normal PHA operation the gain pot R22 is set as described above, the threshold dial is set to the MeV value at the radiation source (e.g. 6.6 for ^{137}Cs to correspond with 660 Kev), the window dial is set for the desired percent window, and the high voltage is adjusted from the Parameters Mode, to make the isotope's radiation peak fall in the middle of the window which is indicated by the maximum reading. In the case just described, full scale on the threshold dial would represent 1 Mev. Full scale on the threshold dial may be set to 2 Mev by setting the dial to 3.3 and adjusting the high voltage to make the peak value of the ^{137}Cs source fall within the middle of the window. This illustrates the normal or most often way the PHA feature is used. There are other ways it may be used, depending on the users application.

The following is an example of calibrating the SRM-200 PHA for a given isotope:

1. Set the threshold to a number to correspond to the peak of the energy of the isotopes emission (e.g. 6.6 for ^{137}Cs).

2. Set the window control for desired window width (e.g. 3.3 for 50 percent window).

3. Set PHA-GROSS switch to PHA.

4. Expose the detector to the isotope of interest and adjust the high voltage until the energy peak lies in the window, indicated by a decrease in reading when the high voltage is adjusted either way. Remove the source to verify that the proper peak was found.

5. Check the GROSS position. The reading will increase if energies above the setting are preset at the detector. Reset to PHA for PHA operation.

As now set up, the nominal span of the threshold control is from zero to 1 Mev. If in step 1, the threshold was set for 3.3 instead of 6.6, the threshold adjustment span would have been from zero to 2 Mev. An alternate method to obtain zero to 2 Mev is to use ^{62}Co (1.25 Mev, average of two peaks) instead of ^{137}Cs and set the threshold at 6.25 in step 1 above.

In all cases where possible, the isotope of interest should be used to make the final setup adjustment to make sure the energy is peaked in the window.

The above method of calibrating the PHA controls is predicated on the amplifier gain pot, R22, having been preadjusted. It is preadjusted at the factory such that a 25 mv input pulse will just cross the threshold when the threshold dial is set at 10. This adjustment may be made by the user provided he uses a calibrated pulser such as an Eberline MP-1 or MP-2.

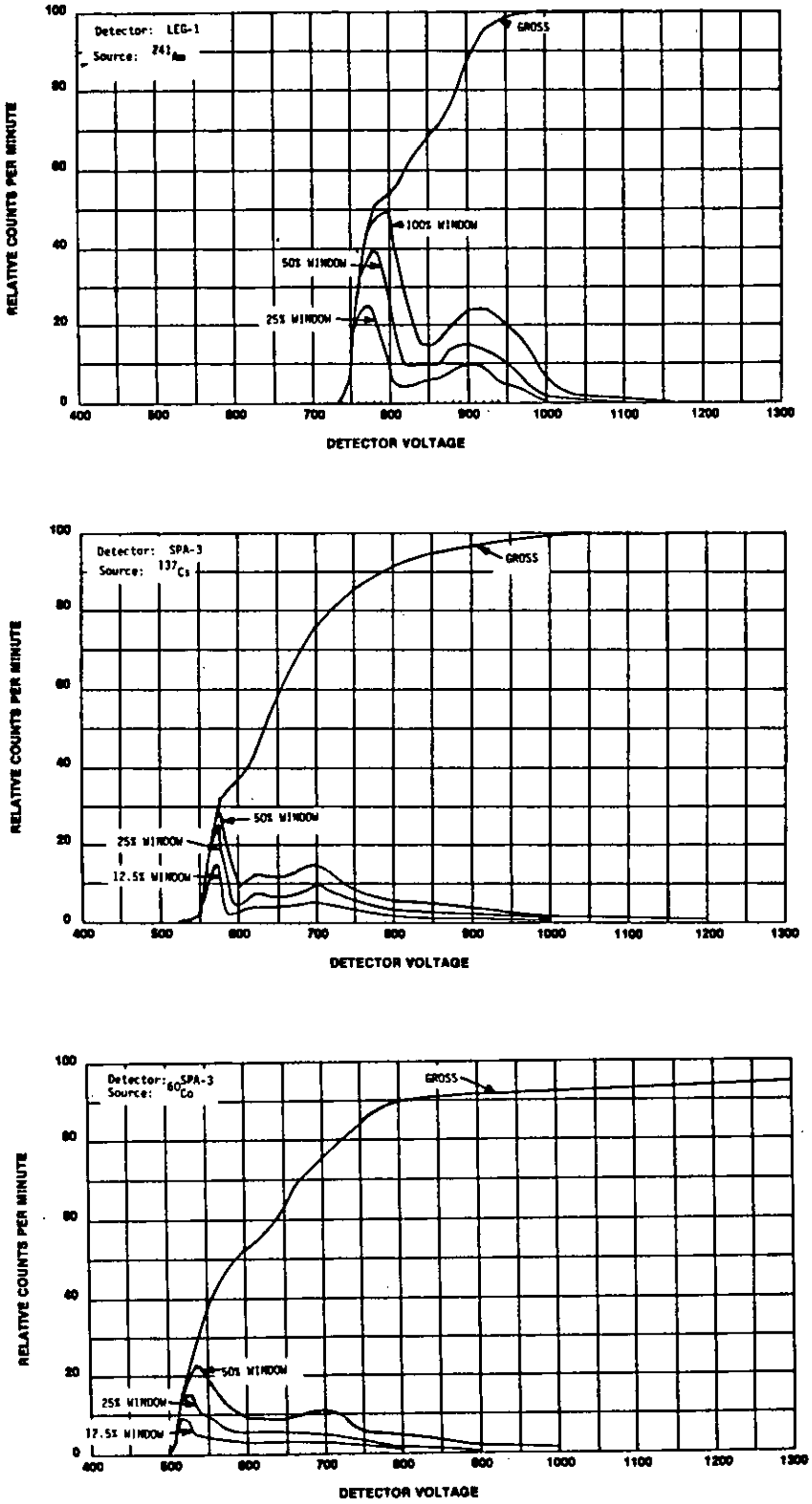


Figure 5-2, Typical PHA Operating Curves, 11383-A37

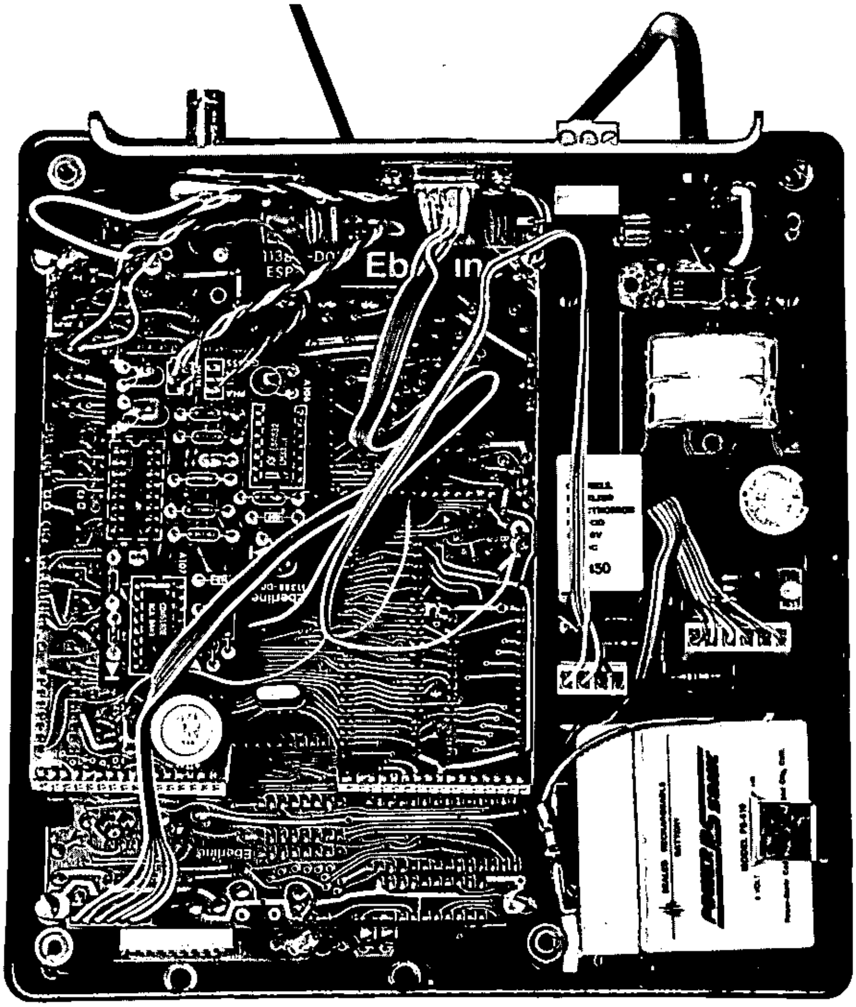


Figure 5-3, SRM-200 with Bottom Cover Removed

C. PREVENTIVE MAINTENANCE

1. Periodic Maintenance

Because of the simplicity of the SRM-200, periodic maintenance is neither time consuming nor overly frequent.

a. Remove the bottom cover and the side and blow out the inside with clean and dry, low pressure air once per year.

b. Keep the outside of the case clean.

c. Open the bottom only when calibration, maintenance, or battery change are necessary.

D. CORRECTIVE MAINTENANCE

1. Disassembly/Assembly

WARNING

When starting screws, exercise care, use screw holders and other proper tools. Don't over tighten!

Use care to minimize the tension on the ribbon cables connecting the PC boards and the display. The cables are short and can be damaged.

a. Removal of PC Boards:

1) Turn the instrument "OFF". Remove AC power. Rest the SRM-200 on its front cover (display down), exercise caution to prevent operation of the pushbutton switches.

2) Remove the back cover by loosening the four screws holding it to the front cover and then lifting carefully to clear components attached to the front cover.

NOTE

For proper orientation the front is the end nearest the battery and keypad. The rear is the end with the detector connector and AC power cord. The AC power cord is attached to the DC power supply board. The ESP basic PC board set is to the left of the DC power supply board. Refer to Figure 5.3.

3) Remove the nut and lockwasher that hold the detector connector at the rear of the instrument.

4) Loosen the two rear screws holding the ESP basic PC board. Remove the remaining four screws (three on the front end and one in the center) holding the ESP-2 and ESP basic PC board set.

5) Disconnect the RS-232 cable from the ESP-2 PC board.

6) Disconnect J2 from the DC power supply. This removes DC power to the board set.

7) The ESP-2 and ESP basic PC board may now be lifted from the rear and gently folded over the front of the instrument so that the component side of the boards are exposed. Most PC board repairs are now possible.

8) To remove these boards completely (including display and keyboard), first remove the two screws holding the keyboard retainer. Removal of the retainer, keyboard and keypad is now possible.

9) Next remove the two screws holding the display case to the front cover. Then remove the four screws holding the display case together. Lift the back case off. Remove the four screws holding the LCD on the front case. Guide the LCD through the slot on the front cover and these boards may now be removed.

10) To remove the DC power supply board, begin by removing the black and red wires from the battery. Disconnect J1, J2 and the AC power cord connections from the board. (Note the color of wire attached to each terminal.) Remove the alarm terminal strip from the plug soldered onto the board.

11) Next remove the three stainless steel screws holding the power supply board to the front cover. There is also a nylon screw going through the regulator (A2) which must be removed. The DC power supply board can now be removed for repair or replacement.

b. Reinstallation of PC boards:

1) Set the DC power supply board in place so that the holes line up with the holes on the front cover. Replace the four screws that attach the board to the front cover. Be sure to use the nylon screw for the regulator (A2), or a short will occur.

2) Reconnect J1, J2 and the AC power cord connectors to the power supply board. Insert the alarm terminal strip into the plug on the rear of the board. (J2 is wired to the ESP basic PC board.)

3) To install the ESP basic PC board set, begin by guiding the LCD through the slot on the front cover. Then fasten the LCD to the front display case, (use the smaller 2-56 screws).

4) Place the speaker in the indent of the front display case and route the speaker wires through the slot between the cases. Mount the back case to the front case with the four screws previously removed. Attach the display case to the front cover by guiding it over the pivot points on the front cover, then inserting the two 6-32 screws through the front cover into the sides of the display case. DO NOT over tighten or the display case will no longer be adjustable.

5) Place the keypads into their respective slots on the front cover. Then place the keyboard over the keypads, the components on the keyboard should be visible and not facing the front cover. The keypad retainer should now be installed over the keyboard and fastened to the front cover with the two screws provided.

6) Place the ESP basic and ESP-2 board set over their mounting holes. The detector connector should be inserted into the slot on the rear panel. Guide the PC board under the rear screws previously loosened to remove the board. Insert the remaining three PC board mounting screws and loosely tighten. Center the PC board under all the screws and then tighten.

7) Install the lockwasher and nut on the detector connector. The hole for the detector connector is keyed to the connector, when these are lined up, tighten the nut.

8) Reconnect J2 to the DC power supply board. This applies power to the amp/HV/computer board set.

2. Troubleshooting

The SRM-200 uses the latest state-of-the-art components and circuitry available at the time of its design. Eberline's experience using similar components has shown them to be very reliable and trouble free. Realizing that failures and problems will occur, this section is intended to assist the technician with the task of repair.

Eberline provides a repair and calibration service at two locations in the United States and one in England for the European market. Contact Eberline for details (see front of manual).

To hold down-time to the minimum possible, users might consider changing the entire printed-circuit-board set. By maintaining a spare board set and exchanging the board set when a failure occurs, down time (including recalibration) can probably be limited to less than one hour. The inoperative board(s) can then be repaired in-house or by Eberline without taking the SRM-200 out of service for lengthy periods of time.

NOTE

Always recalibrate after repair.

a. General Procedure

A thorough understanding of the SRM-200 circuitry and program operation is necessary before any field repairs are attempted. For component problems, review Section IV (Theory of Operation) and the schematic and logic drawings (Section VII). For problems related to operation, review Section III (FUNCTIONAL FLOW DIAGRAMS).

The incorporation of a microcomputer in the SRM-200 does not change the general approach to troubleshooting and repair. In short, the problem must be defined, the trouble isolated, and the defect identified. Only then can effective repair be accomplished.

The circuitry used in the SRM-200 employs CMOS technology. These CMOS devices are sensitive to electrostatic discharge. To prevent damage, they should be properly grounded before and during handling.

Generally, problems can be defined in one of two categories. These would be a nonfunctioning microcomputer or a nonfunctioning counter.

CAUTION

Whenever AC power is applied to the SRM-200 the DC power supply is on and live voltages exist. The internal battery also presents live voltage and due care should be exercised when the rear cover is removed.

NOTE

"Counter" refers to the pulse amplifier, low-voltage circuits, and high-voltage circuits.

A nonfunctioning microcomputer can be recognized by:

1) No information on the display.

2) Erratic display information.

3) Unidentifiable/wrong characters on the display.

A nonfunctioning counter can be recognized by:

1) Ratemeter readout too low.

2) Ratemeter readout too high.

3) Readout not statistical (erratic).

The first step in determining any problem should be the condition of the power supply and battery. With the instrument plugged into an AC line, measure the voltage across the battery. It should be between 5.9 and 7.1 volts. If it isn't, try adjusting per the procedure described in paragraph A. CALIBRATION, at the beginning of this section.

If unable to adjust to the proper voltage, possible causes are:

1) DC power supply is bad.

2) DC power supply is too heavily loaded. Disconnect battery leads and J2 to remove loads and isolate problem.

With AC power removed and the battery voltage within 5.9 and 7.1 volts, measure the current drain of the battery. When the instrument is OFF the current drain should be less than 250 μA. when the SRM-200 is ON and not alarmed, current drain should be less than 30 mA. If the drain is too high in either condition, isolate the faulty component and replace it.

The second step is to check all voltages, using Table 5-4 which follows.

NOTE

A mating connector such as Circuit Assembly #CA-24, EC-3-SE-20GT (Eberline part No. SOPC124(7)) can be installed on the test connector to provide easier access to the test pins.

Table 5-4. Check Voltages

TEST CONNECTOR (FIG. 3-1)	DESIGNATION	LIMITS	DESCRIPTION
2	V_B	+5.8 to +10V	Battery voltage
20	V_C	+4.97 to +5.03V	Regulated low voltage
24	+V	+4.85 to +5.0V	Switched V_C
4	V_{BB}	+5.5 to +9.7V	Switched V_B
18	GND	--	Reference

Any voltage not meeting the limits set, establishes a reason for repair before proceeding. See "Repairing LV Supply," which follows below.

b. Nonfunctioning Microcomputer

1) Check the "TEST" switch (S2-B). Its switch arm should be set in the ON position. Reinitialize the computer by:

   a) Disconnect J2 (power supply).

   b) Discharge C28 (.047 F capacitor) by removing the bottom cover and pressing RESET switch. This will discharge C28. (See Figure 5-3.) Allow 10 seconds.

   c) Reconnect J2.

NOTE

Reinitializing the computer resets all parameters including HV calibration. Recalibration of programmed parameters should be performed before putting instrument back into service.

2) Remove lower PC board to expose the upper PC board. Check all the integrated circuits (ICs) for proper seating in their sockets. If a loose IC is found, replace the batteries and repeat Step 1 above. If the problem persists, proceed to Step 3.

3) This leaves the following possibilities:

   a) Shorted keypad switch or test connector.

   b) C27 shorted.

   c) A108 or X1 inoperative.

   d) A111 inoperative.

   e) A1 inoperative.

   f) A2 inoperative.

   g) A109, A110, or A5 inoperative.

   h) Display not operating.

   i) Damaged PC board or ribbon cable(s).

c. Nonfunctioning Counter

A nonfunctioning counter usually results because either the counter has failed or the counter is noisy.

NOTE

The instrument must be turned OFF and back ON to reset an "OVERRANGE" condition. An OVERRANGE indication could be caused by an incorrect "DT" setting for the detector in use.

In either case, first determine that the condition is not caused by the detector or cable. The best way to do this is to connect a known good detector and cable then check the operation.

Next, remove the lower board so its components are exposed. Visually inspect for loose and/or poorly seated components, broken wires, broken components, etc.

If the counter has failed, check:

1) High voltage at the detector connector. Use a voltmeter with 1000 megohm or greater input impedance. The voltage should be set for the detector being used. If not correct, see "Repairing the HV Supply" below before proceeding.

2) Amplifier output at pin 7 of A101 using an oscilloscope with an Eberline MP-2 (or MP-1) connected to the detector connector. Set the pulser to 15 mV and 40k counts per minute.

   The positive pulse on the scope should be 2.0 volts or greater. If good, go to step 3 below.

If bad the probable causes are:

a) A101 inoperative.

b) Q3 inoperative.

c) CR4 shorted.

d) C11 defective.

3) Discriminator output at pin 10 of A101 using the scope (MP-2 still connected and set as in step 2 above). This should be a negative square pulse of 4.0 volts or greater. If good, go to step 4 below.

If bad, the probable causes are:

a) A101 inoperative.

b) THRESHOLD control (R28) defective.

c) A105 inoperative.

4) Binary output at pin 9 of A105 using the scope (MP-2 still connected and set as in step 2 above). This signal should change state at the rate of the MP-2 and switch between ground and 4.0 volts or greater.

If the signal is not present, A105 is bad.

If the signal is present, move the scope to pin 14 of A108 (microcomputer chip). The signal should be as above. If it is, A108 is bad. If not, check for damaged PC board, or bad contact at A108 pin 14.

If the counter is noisy, the most common causes of counter noise are:

- High voltage too high.

- Loose or bad ground connections.

- High voltage breakdown.

- Input sensitivity (R27 THRESHOLD), set too sensitive.

- Noisy low voltage supply.

Loose or bad ground connections are best detected by visual inspection. Check for:

a) Damaged PC board.

b) Broken wire(s) in ribbon cables.

c) T1 frame is jumpered to ground.

If the high voltage is too high, try readjusting it (keypad control in Parameters Mode). If it will adjust and control, then check with the detector to prove the fix.

If the high voltage does not adjust and/or control, go to "Repairing the HV Supply", below.

Breakdown or arcing of the high voltage is normally caused by a dirty PC board, damaged component, or dirty/bad detector connector.

Input sensitivity can easily be checked using an Eberline MP-2. Check it with reference to Table 5-1. If the input sensitivity is too high, reset it to the proper value and check instrument operation. If it is still noisy, proceed.

Check the low voltage (V_c, +V) using a scope. The AC component should be less than 10mV. If not, the probable causes are:

- A104 inoperative (if noise is on V_c).

- Q6 defective.

- Leaky filter capacitors.

d. Repairing the HV Supply.

NOTE

All measurements of the high voltage require a voltmeter of 1000 megohms or greater input impedance. Use an electrostatic voltmeter or a special high voltage arrangement such as a Fluke model 8020A with 80K-40 high voltage probe.

It is normal that the high voltage will fluctuate around the control point (±2 percent). Adjust HV using the HV controls in the Parameters Mode.

The actual HV output value matches ±2 percent, the HV display reading in the voltage range from 600 Vdc to 1,800 Vdc. Outside this range the actual HV output matches the display reading +2 percent, -10 percent due to D/A nonlinearities.

1) No high voltage. Probable causes:

a) Q2 and/or T1 defective.

b) Q1 defective.

c) A100 inoperative.

d) CR1, CR2, or CR3 defective.

e) C8 defective.

f) HV reference (A100, pin 10) not right value.

2) HV too high. Probable causes:

a) A100 inoperative.

b) Q1 defective.

c) C8 defective.

d) R1 defective.

3) Fluctuating high voltage (see note above). Probable causes:

a) A100 inoperative.

b) R1 defective.

e. Repairing the LV Supply

1) V_c Low.

Check for excessive current drain. Isolate to faulty component by removing one IC at a time until fault is found.

2) V_c High.

Replace A104.

3) Error in +V. Probable causes:

a) Q6 defective.

b) "PWR ON" from computer > 0.4 volts.

c) Excessive current drain on +V supply.

4) Error in V_{BB}. Probable causes:

a) Q8 defective.

b) Q7 defective. Also check Q2 and C10.

f. Speaker Nonfunctioning (Note: Check S1-A, S1-B, S3-A, and S3-B for proper settings.) Probable causes:

1) Speaker defective.

2) Q4, Q5 defective.

3) A102 inoperative.

4) S1-A, S1-B, S3-A, or S3-B defective.

5) CR6 defective.

6) "SPKR" from computer > 0.4 volt with speaker ON. Check contact at pin 8 of A108, and board damage. If they are satisfactory, A108 or keypad switch is defective.

7) A105 inoperative.

If speaker works but alarm does not:

a) CR5 defective.

b) "ALM" from computer > 0.4 volt when in alarm condition. Check contact at pin 7 of A108, and board damage. If they are satisfactory, A108 is inoperative.

g. Start up problems with computer printer connected.

Some computers and printers may cause start up problems when connected to the SRM-200. If the computer or printer is turned on and the SRM-200 is turned off when the connection is made, the SRM-200 may be reluctant to start. This can usually be over come by operating the SRM-200 ON/OFF button several times or by turning the SRM-200 on before connecting the communications cable. A more permanent solution involves adding a resistor to the SRM-200 main board. Contact Eberline at either customer service location or request insert sheet 1802.

Section 6

SECTION VI. PARTS LIST

The following table lists the electrical and mechanical items incorporated in the SRM-200 and should contain any part necessary for normal repair. Unless otherwise specified, callouts of manufacturers and manufacturers' part numbers are to be considered typical examples only and not restrictions against using equivalent parts with the same operating characteristics. When ordering parts from Eberline, specify model number, serial number, reference designation, value, Eberline part number, or a word description if the part has no reference designation. Eberline will automatically substitute equivalent parts when the one called out by the manufacturers' part number is not available.

1. PC Board Set (2 boards plus display) EIC #YP11384000

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
A100	Integrated Circuit	Operational Amplifier	Motorola MC14573CP	ICAOA14573(7)
A101	Integrated Circuit	Operational Amplifier	Motorola MC14575CP	ICAOA14575(5)
A102	Integrated Circuit	Quad 2 input Nor Gate	RCA CD4001BE	ICCMA4001B(8)
A104	Integrated Circuit	Regulator	National LP2950CZ	ICAVA2950C(9)
A105	Integrated Circuit	12 Bit Binary Counter	RCA CD4040BE or SGS HFC4040BE	ICCMA4040B(6)
A108	Integrated Circuit	Microprocessor	Intel 80C31	ICCMA80C31(8)
A109	Integrated Circuit	Decoder	National MM74HC138	ICCMAHC138(5)
A110	Integrated Circuit	Nor Gate	Texas Inst. SN74HC36	ICCMA4HC36(8)
A111	Integrated Circuit	EPROM	Intel 87C64	ICCMA87C64(3)
A112	Integrated Circuit	8 Bit D/A Converter	Analog Devices AD7524JN	ICCMA07524(9)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
C1	Capacitor	0.05 uF, 10%, 3.5 kV	Capco EBL-1 (Special)	CPPF503PXY(9)
C2, C4	Capacitor	0.01 uF, 20%, 3 kV	Sprague 30GA-S10 or Centralab DD30-103	CPCE103P4Y(3)
C3	Capacitor	0.001 uF, 10%, 3kV	Centralab DD30-102	CPCE102P3Y(7)
C5, C14	Capacitor	0.1 uF, 10%, 50 V	Centralab CW20C104K	CPCE104P3N(7)
C6	Capacitor	0.1 uF, 10%, 80 V	Sprague 192P1049R8	CFFF104P3O(4)
C7	Capacitor	.0033 uF, 10%, 200 V	Sprague 192P33292	CPPF332P3P(0)
C8	Capacitor	0.47 uF, 10%, 35 V	Kemet T110A474K035AS	CPTA474P3L(6)
C9	Capacitor	0.27 uF, 20%, 50 V	Centralab CW30C274M	CPCE274P4N(6)
C10, C29	Capacitor	33.0 uF, 10%, 10 V, Tantalum	Sprague 196D336X9010KA1	CPXX12(8)
C11	Capacitor	220.0 pF, 10%, 3 kV	Centralab DD30-221	CPCE221P3Y(5)
C12, C19	Capacitor	0.047 uF, 20%, 50 V	Sprague IC25Z5U473M0508	CPCE473P4N(4)
C13, C27	Capacitor	10.0 uF, 20%, 16 V, Tantalum	Sprague 199D106X0016CB1 or ITT TAP-B10K35	CPTA100M4X(3)
C15	Capacitor	820.0 pF, 10%, 100 V	Erie CK12BX821K	CPCE821P3P(4)
C16, C20, C21	Capacitor	100.0 pF, 50 V	AVX SP155A101KAA	CPCE101P3N(3)
C17	Capacitor	1000.0 pF, 10%, 100 V	Centralab CN20A102K	CPCE102P3P(9)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
C18	Capacitor	0.022 uF, 10%, 100 V	Kemet C062C223K1X1CA	CPCE223P3P(3)
C25	Capacitor	0.01 uF, 10%, 80 V	Sprague 192P1039R8	CPPF103P30(6)
C28	Capacitor	0.047 F, 5 V	NEC FAOH473Z	CPSP473MXC(2)
C30	Capacitor	15.0 uF, 10%, 20 V, Tantalum	Sprague 196D156X9020KA1	CPXX10(0)
C31	Capacitor	0.01 µF, 10%, 50 V	Centralab CK103	CPCE103PXN(4)
C36, C37	Capacitor	33.0 pF, 10%,	Erie CK12BX330K	CPCE330P3P(6)
CR1, CR2, CR3	Diode	Silicon	Varo VA25	CRSIVA0025(3)
CR4, CR5, CR6, CR7, CR10, CR11,	Diode	Silicon Switching	1N4148	CRSI1N4148(7)
DS1	Bulb	T-1 1/4, 6 V, 60 mA incandescent	Chicago Mini, CM2114D	LPBU17(9)
Q1, Q4, Q5, Q10, Q11	Transistor	NPN, Silicon	2N4401	TRSN2N4401(6)
Q2	Transistor	PNP, Silicon	Motorola 2N4234 or National 2N4234, 2N4236	TRSP2N4234(7)
Q3	Transistor	NPN, Silicon	2N5088	TRSN2N5088(3)
Q6, Q8	Transistor	PNP, Silicon	2N4403	TRSP2N4403(2)
Q7	Transistor	NPN, Silicon	2N4124	TRSN2N4124(2)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
R1	Resistor	1000M/1M, 10 percent, Voltage Resistive Divider	TRW/IRC RD4-1KM/1M-10%	REXX22(4)
R2	Resistor	100 k, 5%, 1/4 W, Carbon Composition		RECC104B22(0)
R3	Resistor	10 M, 5%, 1/4 W, Carbon Composition		RECC106B22(5)
R4, R49, R75	Resistor	1 k, 5%, 1/8 W, Carbon Composition		RECC102B21(5)
R5	Resistor	62 k, 5%, 1/8 W, Carbon Composition		RECC623B21(0)
R6, R8	Resistor	30 k, 5%, 1/8 W, Carbon Composition		RECC303B21(9)
R7, R47	Resistor	100 ohm, 5%, 1/8 W, Carbon Composition		RECC101B21(7)
R9, R16, R21, R25, R26	Resistor	20 k, 1%, 1/4 W	RN55D	RECE203B12(0)
R10	Resistor	470 ohm, 5%, 1/8 W, Carbon Composition		RECC471B21(4)
R11, R51	Resistor	510 k, 5%, 1/8 W, Carbon Composition		RECC514B21(1)
R12	Resistor	270 ohm, 5%, 1/4 W, Carbon Composition		RECC271B22(7)
R13	Resistor	47 k, 5%, 1/8 W, Carbon Composition		RECC473B21(0)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
R14, R52	Resistor	270 k, 5%, 1/8 W, Carbon Composition		RECC274B21(2)
R15, R18	Resistor	2.1 k, 1%, 1/4 W	RN55D	RECE212B12(1)
R17	Resistor	68.1 k, 1%, 1/4 W	RN55D	RECE683B12(3)
R19, R20, R29, R67	Resistor	150 k, 1%, 1/4 W	RN55D	RECE154B12(5)
R22	Potentiometer	100 k, 1/2 W	Spectrol 64X104	PTCE104B83(8)
R23, R24	Resistor	200 k, 1%, 0.1 W	RN50	RECE204B11(9)
R27	Potentiometer	10 k, 1/2 W	Spectrol 64X103	PTCE103B93(8)
R28	Resistor	10 k, 1%, 1/4 W	RN55D	RECE103B12(2)
R30	Resistor	22 ohm, 5%, 1/4 W, Carbon Composition		RECC220B22(4)
R43	Resistor	20 k, 5%, 1/8 W, Carbon Composition		RECC203B21(1)
R44	Resistor	22 k, 5%, 1/8 W, Carbon Composition		RECC223B21(0)
R45, R76	Resistor	10 k, 5%, 1/8 W, Carbon Composition		RECC103B21(3)
R46	Resistor	100 k, 5%, 1/8 W, Carbon Composition		RECC104B21(1)
R50	Resistor	18 k, 5%, 1/8 W, Carbon Composition		RECC183B21(5)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
R54, R62	Resistor	75 k, 5%, 1/8 W, Carbon Composition		RECC753B21(5)
R55	Resistor	3.3 k, 5%, 1/8 W, Carbon Composition		RECC332B21(8)
R56	Resistor	130 k, 1%, 0.1 W	RN50	RECE134B11(8)
R57	Resistor	100 k, 1%, 0.1 W	RN50	RECE104B11(1)
R63	Resistor	12 ohm, 5%, 1/8 w, Carbon Composition		RECC120B21(7)
R64	Resistor	270 ohm, 5%, 1/8 W, Carbon Composition		RECC271B21(8)
R65	Resistor	1 M, 5%, 1/8 W, Carbon Composition		RECC105B21(8)
R66	Potentiometer	200 k, 1/2 W	Spectrol 64X204	PTCE104B83(7)
R68	Potentiometer	500 k, 1/2 W	Spectrol 64X504	PTCE504B23(2)
R69	Resistor	562 k, 1%, 1/4 W	RN55D	RECE564B12(5)
R70, R71	Resistor	49.9 k, 1%, 1/4 W	RN55D	RECE493B12(7)
R72, R73	Resistor	536 ohm, 1%, 1/4 W	RN55D	RECE531B12(4)
R74	Resistor	4.7 k, 2%, SIP (4 resistor array)		REAR472B12(0)
S5	Switch	Pushbutton	Alco TPA11CG-PC	SWPB17(0)
T1	Transformer	Blocking Oscillator	Microtran M8149	TFHV5(3)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
X1	Crystal	7.373 MHz	International Crystal 4-33273	CYOS12(5)
2. ESP-2 PC Board EIC #YP11385000(0)				
A1	Integrated Circuit	Octal Buffer	National 74HC373 or 54HC373J	ICHCA74373(2)
A2	Integrated Circuit	EPROM	Intel 27C64	ICCMA27C64(9)
A3	Integrated Circuit	RAM	Hitachi HM6264LP-15	ICCM6264(9)
A4	Integrated Circuit	Hex Bus Driver	National MM74HC365	ICHC74365(0)
A5	Integrated Circuit	Decoder	National MM74HC138	ICCMAHC138(5)
A6	Integrated Circuit	Clock, Real Time	OKI Semiconductor MSM6242RS	ICCM6242(6)
A8	Integrated Circuit	RS-232 Xmitter/ Receiver	Maxim MAX232EPE	ICXXA32EPE(2)
C1, C2	Capacitor	18 pf, 10%, 100 V	Erie ET05-000COG-0180K	CPCE180P3P(5)
C5, C6, C11	Capacitor	0.1 uF, 10%, 100 V	Erie CK06BX104K	CPCE104P3P(5)
C7, C8, C9, C10	Capacitor	22 uF, 20%, 15 V	Sprague 196D226X9015KA1	CPTA220M4H(0)
R1	Resistor	30 k, 5%, 1/8 W, Carbon Composition		RECC303B21(9)
R2	Resistor	3 k, 5%, 1/4 W, Carbon Composition		RECC302B22(0)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
R3	Resistor Array	1 Meg, 5%, Resistor SIP, 1 common pin		REAR105B21(5)
R12	Resistor	510 k, 5%, 1/4 W, Carbon Composition		RECC514B22(0)
X1	Crystal	Quartz, 32.768 KHz, 0.003%	Statek	CYOS08(1)
J1	Connector	7 Pin, PC Board Mounted	Molex 22-23-2071	COMR107(4)

3. DC Power Supply Board EIC #YP11341000(3)

A1	Bridge Rectifier		VARO8 VS148	CRARVS0148(7)
A2	Voltage Regulator		Motorola MC7806CT	ICAV7806(4)
C1	Capacitor	470 µF, 50V	Type 503D	CPFAL471M3N(8)
CR1	Diode		1N4001	CRSI1N4001(3)
CR2	Diode		1N4148	CRSI1N4148(7)
F1	Fuse	1/8A, 250V	SLO-BLO, 3AG	FUSB2(1)
R1	Resistor	10K, 1/4W, 5%	Carbon Composition	RECC103B22(2)
R2	Potentiometer	2K, 1/2W, 5%	Spectrol 64Y-202	PTCE202B23(3)
R3	Resistor	680 ohm, 1/4W, 5%	Carbon Composition	RECC681B22(7)
R4	Resistor	270 ohm, 1/4W, 5%	Carbon Composition	RECC271B22(7)
R5	Resistor	12 ohm, 1/4W, 5%	Carbon Composition	RECC120B22(6)
K1	Relay	6V, SPDT	CDE-603	RLGP22(0)
S1	Switch	Slide, 115-230	C-W,GF-326-0073	SWSL3(0)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
S2	Switch	Slide, SPDT	Chicago Sw. (ITW) 124-240-020	SWSL10(4)
T1	Transformer	10V C.T. @ 6A	PSD4-10	TFPO38(0)
	Connector Tab	Faston, AC Power	Amp #61134-1	TEQC3(1)
	Connector	Faston-Battery Connector	Amp #60972-2	TEQC7(2)
P1	Connector	6 pin connector	Molex 09-60-1061	COMR406(0)
P2	Connector	4 pin connector	Molex 09-60-1041	COMR304(7)
	Terminal Strip	3 conductor (Alarm Connector)	Phoenix #MSTB 1.5/3	COTB61(5)
	Fuse Clip		Littelfuse #102071	FUCL2(1)

4. Miscellaneous Parts

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
	Display	2 line x 16 character (LCD)		OPDS19(8)
	Flat Cable	Keyboard cable (9 conductor)		WRFC1633(0)
	Flat Cable	Display cable (14 conductor)		WRFC1632(4)
	Flat Cable	ESP-2 PC Board (16 conductor)		WRFC1631(2)
	Connector Housing	J1 Connector Housing	Molex 10-11-2073	COMR207(2)
	Terminals	Crimp	Molex 08-50-0005	COHD110(7)
	Harness	RS232		ZP11395045(4)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
SK1	Speaker	2 in. Dia. x 11/16, Dp., 8 ohm	Speco U260	ADSP3(6)
DS1	LED	Amber (AC ON)	H-P 5082-4550	OPLP15(8)
DS2	LED	Red (ALARM)	H-P 5082-4655	OPLP10(3)
	Keypad			ZP11383002(1)
	Keypad Retainer			ZP11373008(6)
BT1	Battery	6V, Gel-cell	Globe-Union GC-610-1B	BTGC2(3)
	Battery Clamp			ZP11373009(5)
J1	Connector Housing	6 place	Molex 09-50-7061	COMR106(6)
	Crimp Pin	Sockets for J1, J2	Molex 08-50-0106	COHD11(7)
J2	Connector Housing	4 place	Molex 09-50-7041	COMR104(1)
	AC Power Cord		Belden 17239	WRAC8(5)
	Strain Relief	For AC Power Cord	Heyco SR-5P-4	WRSR1(7)
	Detector Connector	MHV Receptacle	Amphenol 27025	CXMH2(7)
	Foot	Rubber	Hecht SJ5005X	MMRU62(7)
	Display Case	Front & Back		ZY11395004(1)
	Pivot Plate	For Display Case		ZP11373002(2)
	Housing	Front		ZP11395004(3)
	Housing	Back		ZX11395004(2)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
	Back Plate	For Detector Connector RS-232 Connector, and AC Cord		ZP11395044(5)

5. SRM-200 Options

YP11395047, PHA

RS-232 Cable Assemblies:

CA-40-80, ESP-2 to Printer.
CA-41-80, ESP-2 to IBM-AT Computer.
CA-42-80, ESP-2 to IBM-PC Computer.

YP11383011, Demo Software (includes ESP-2 Communication Specification, EIC #13000-A08).

Section 7

SECTION VII. DIAGRAMS

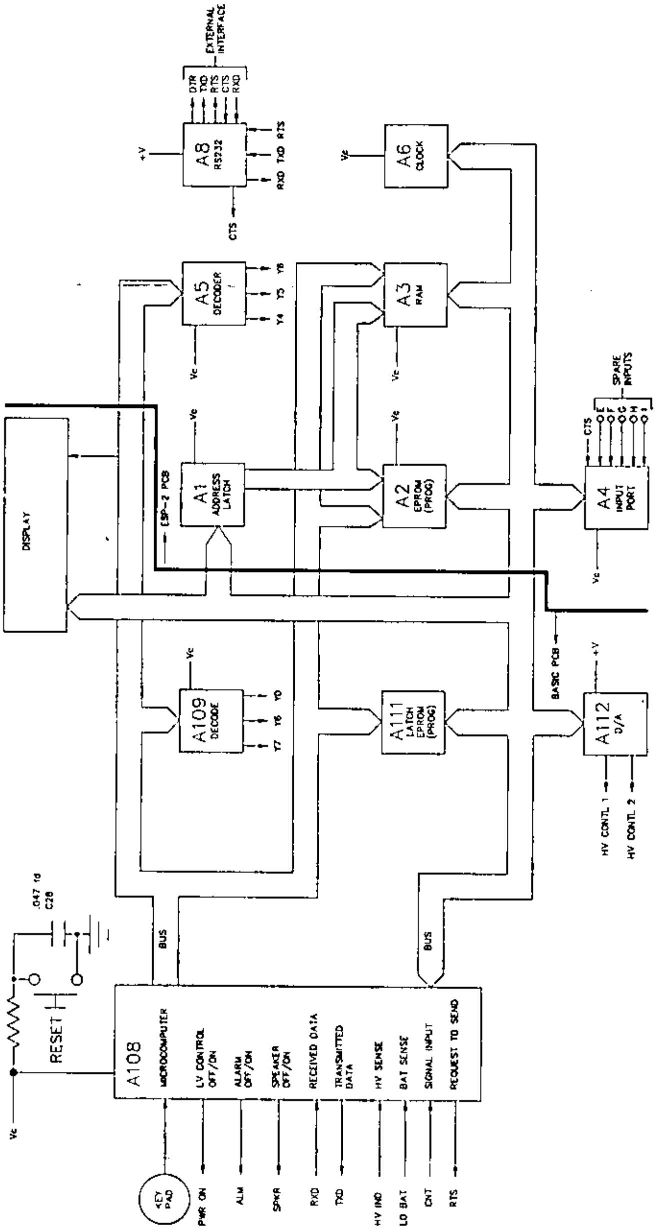


Figure 7-1, Functional Block Diagram, Micro-computer, 11383-C32

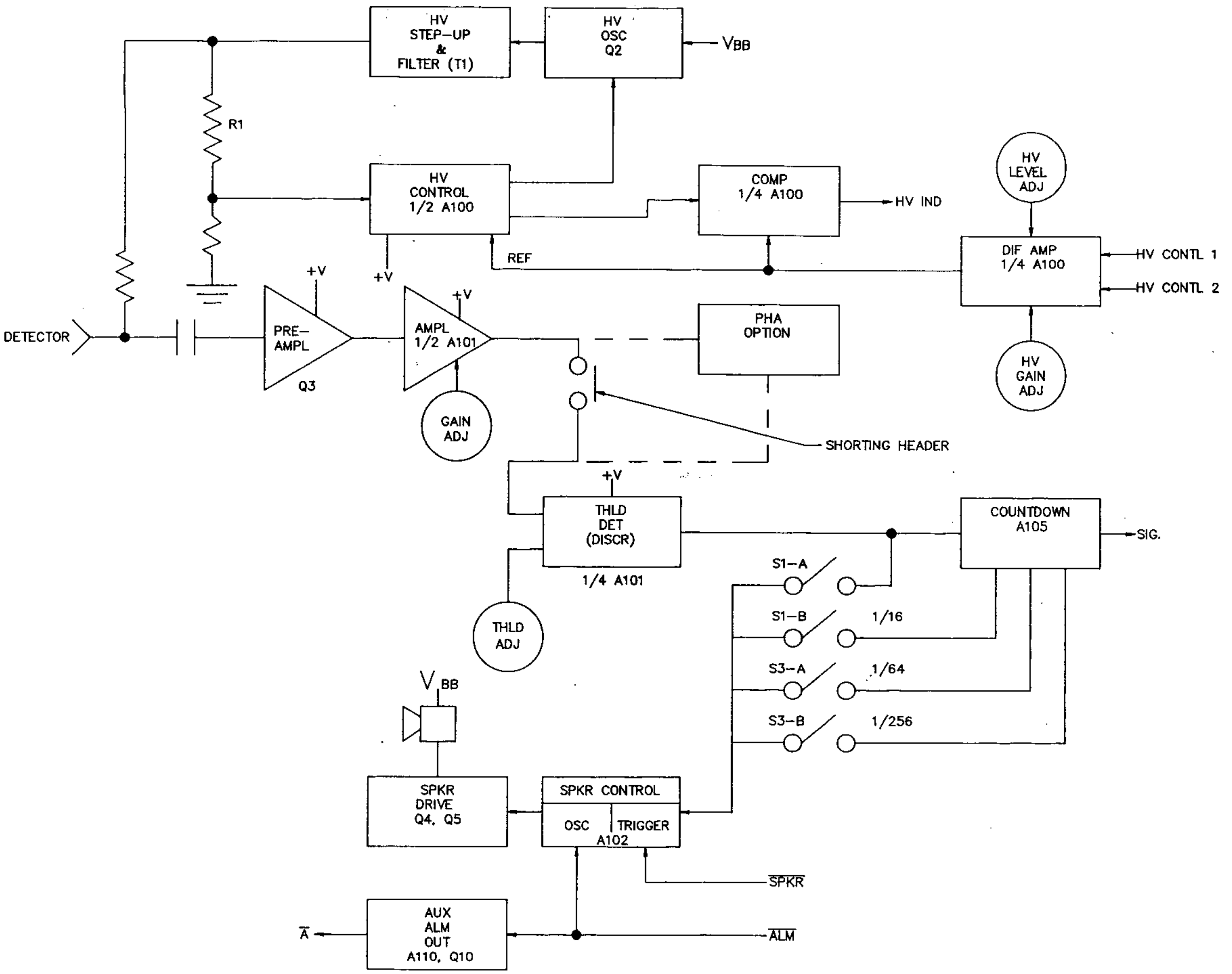


Figure 7-2, Functional Block Diagram, Amplifier, High Voltage and Speaker, 11383-C33

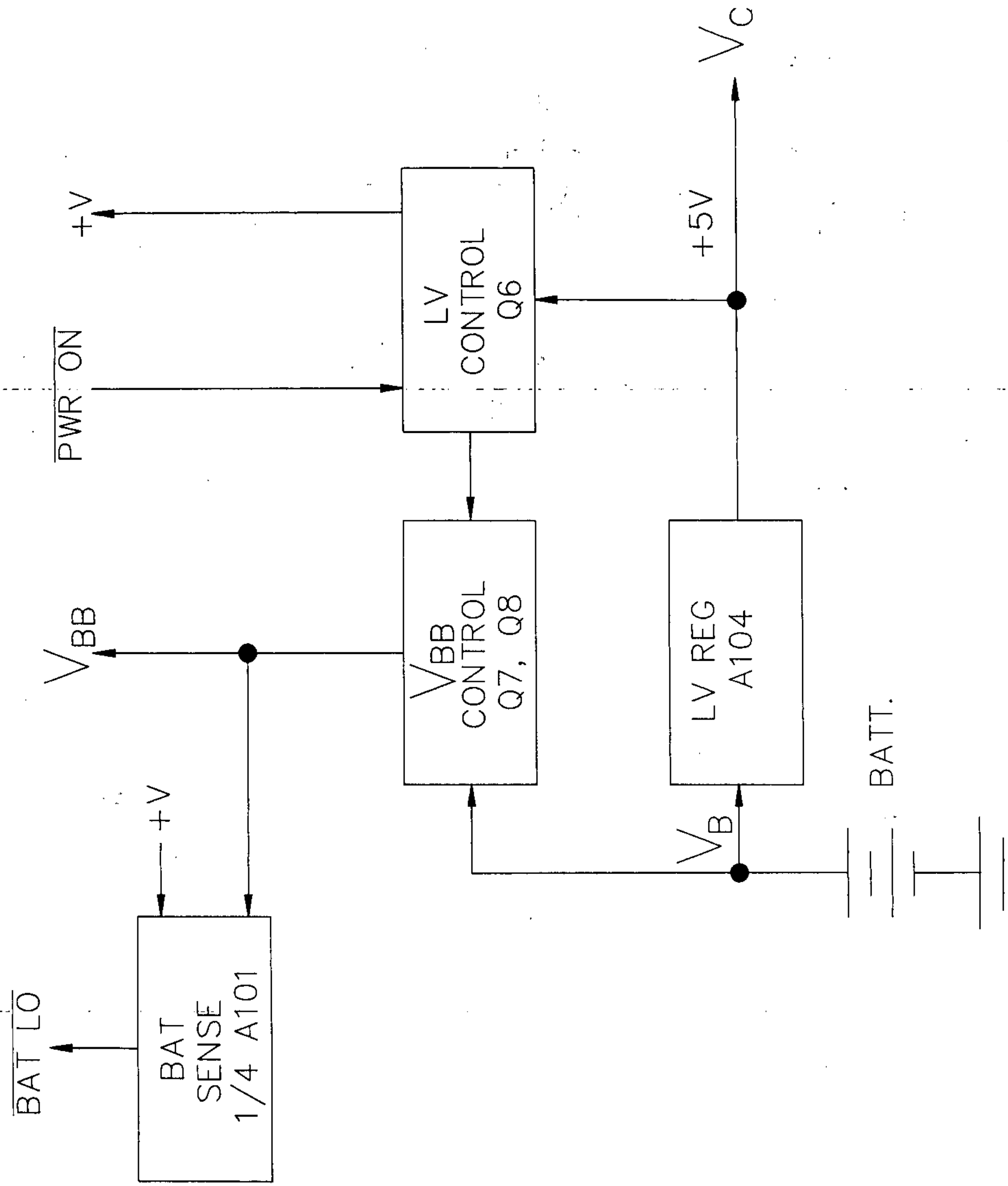
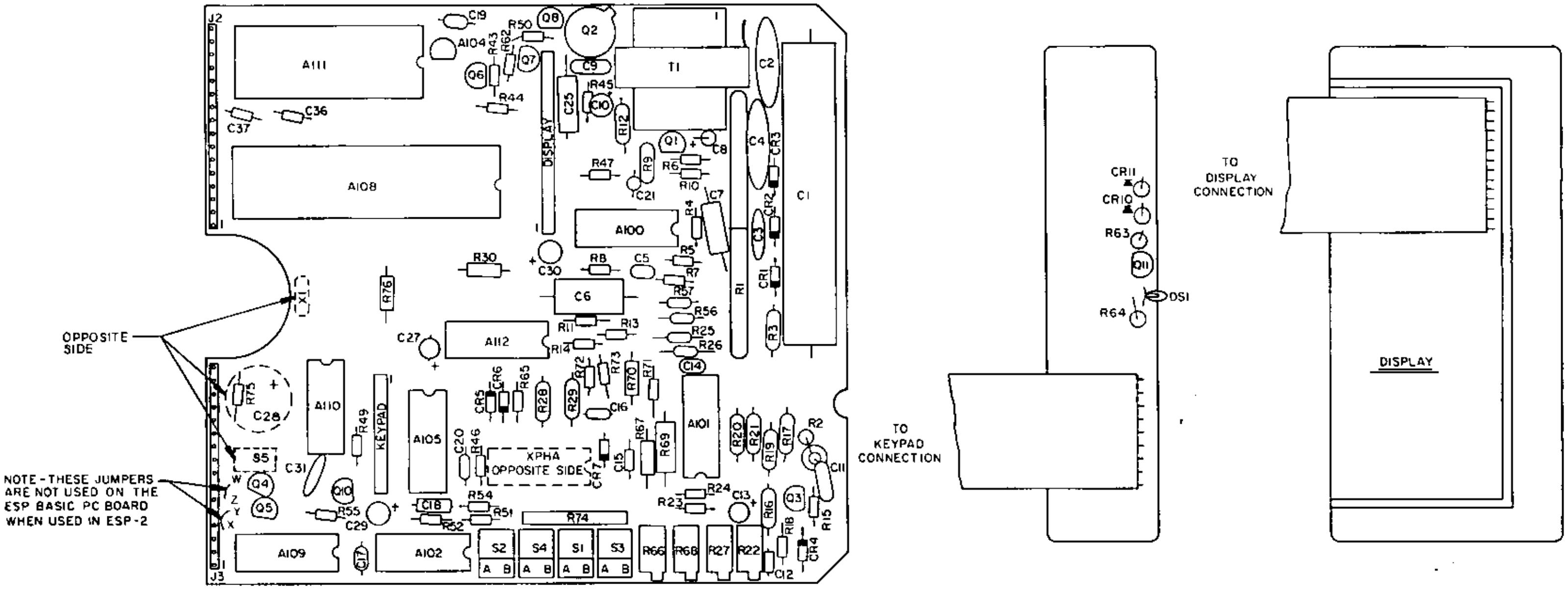


Figure 7-3, Functional Block Diagram, Low Voltage, 11383-C34



OPPOSITE SIDE

NOTE - THESE JUMPERS ARE NOT USED ON THE ESP BASIC PC BOARD WHEN USED IN ESP-2

Figure 7-4, Component Layout, ESP Basic PC Board Assembly, 11384-D05A

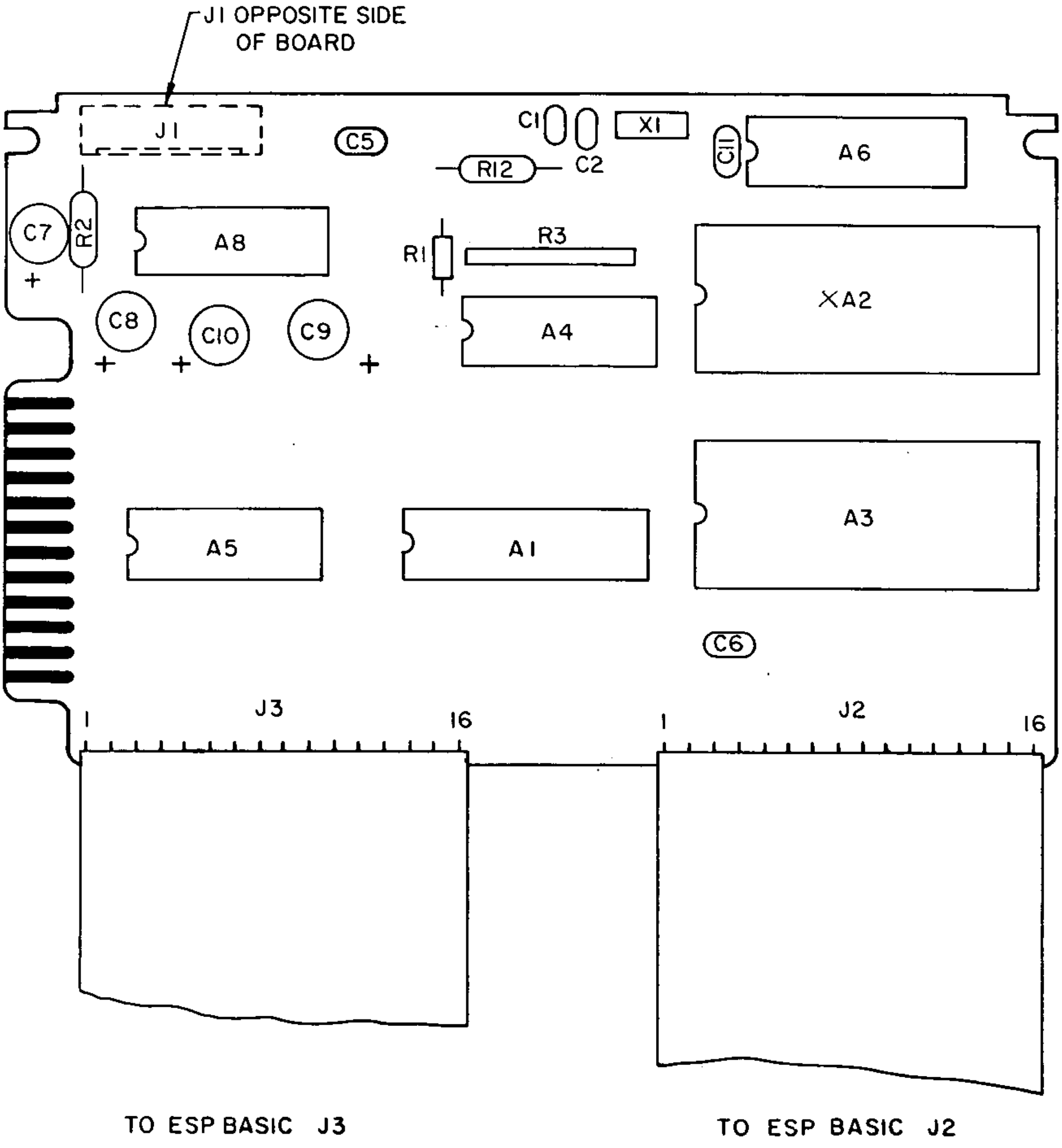


Figure 7-5, Component Layout, ESP-2 PC Board Assembly, 11385-C04

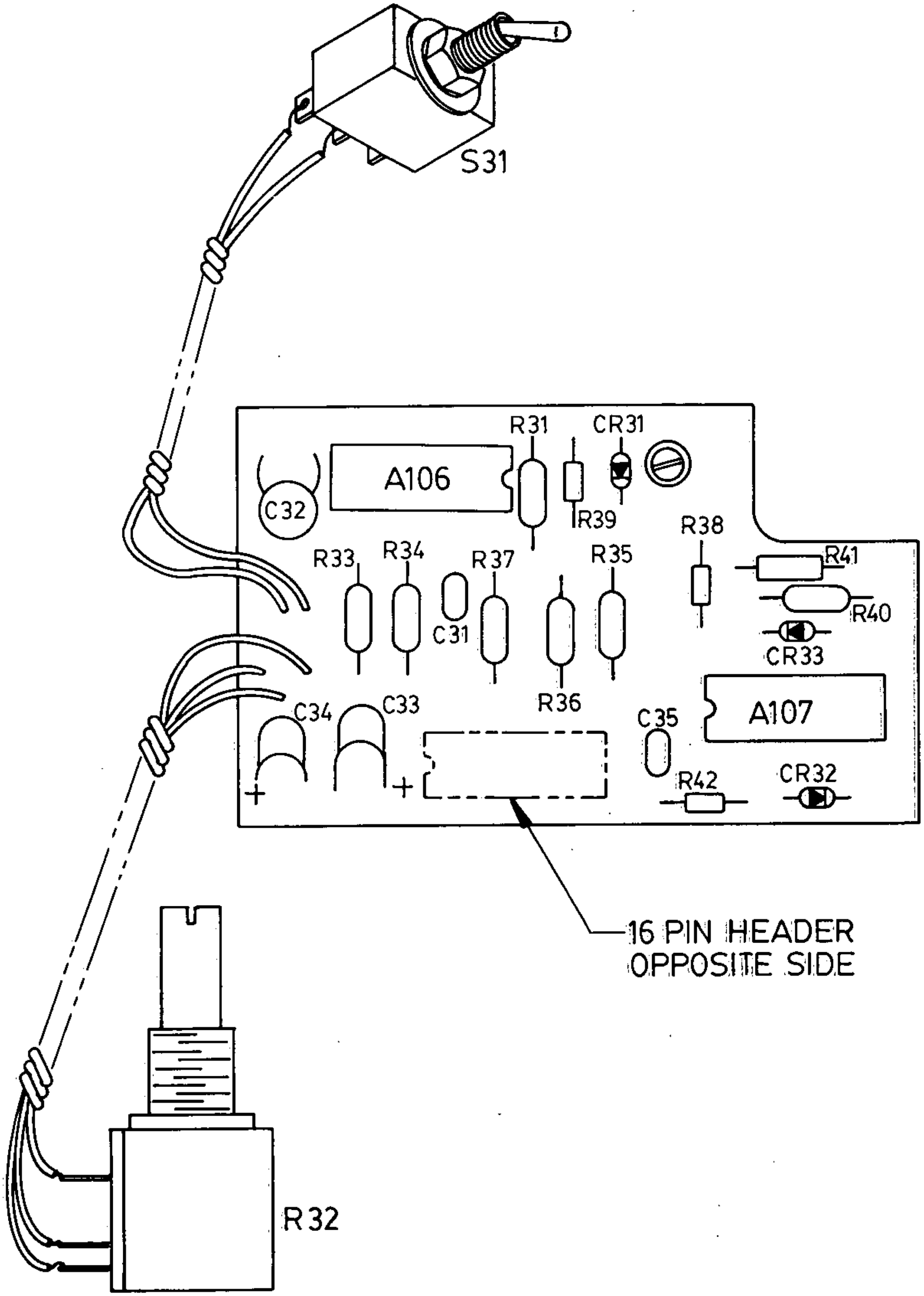


Figure 7-6, Component Layout, SRM-200 PHA PC Board Assembly, 11395-C60

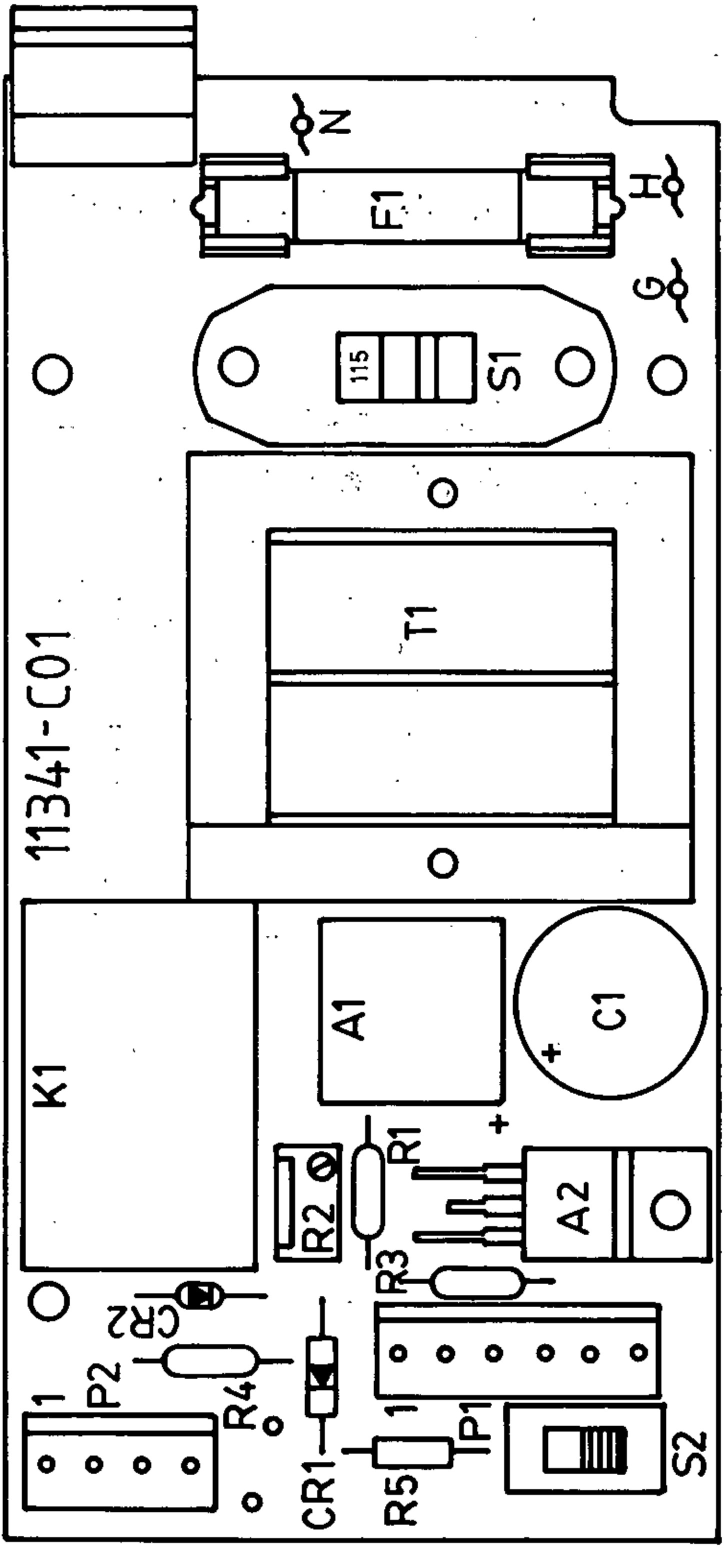
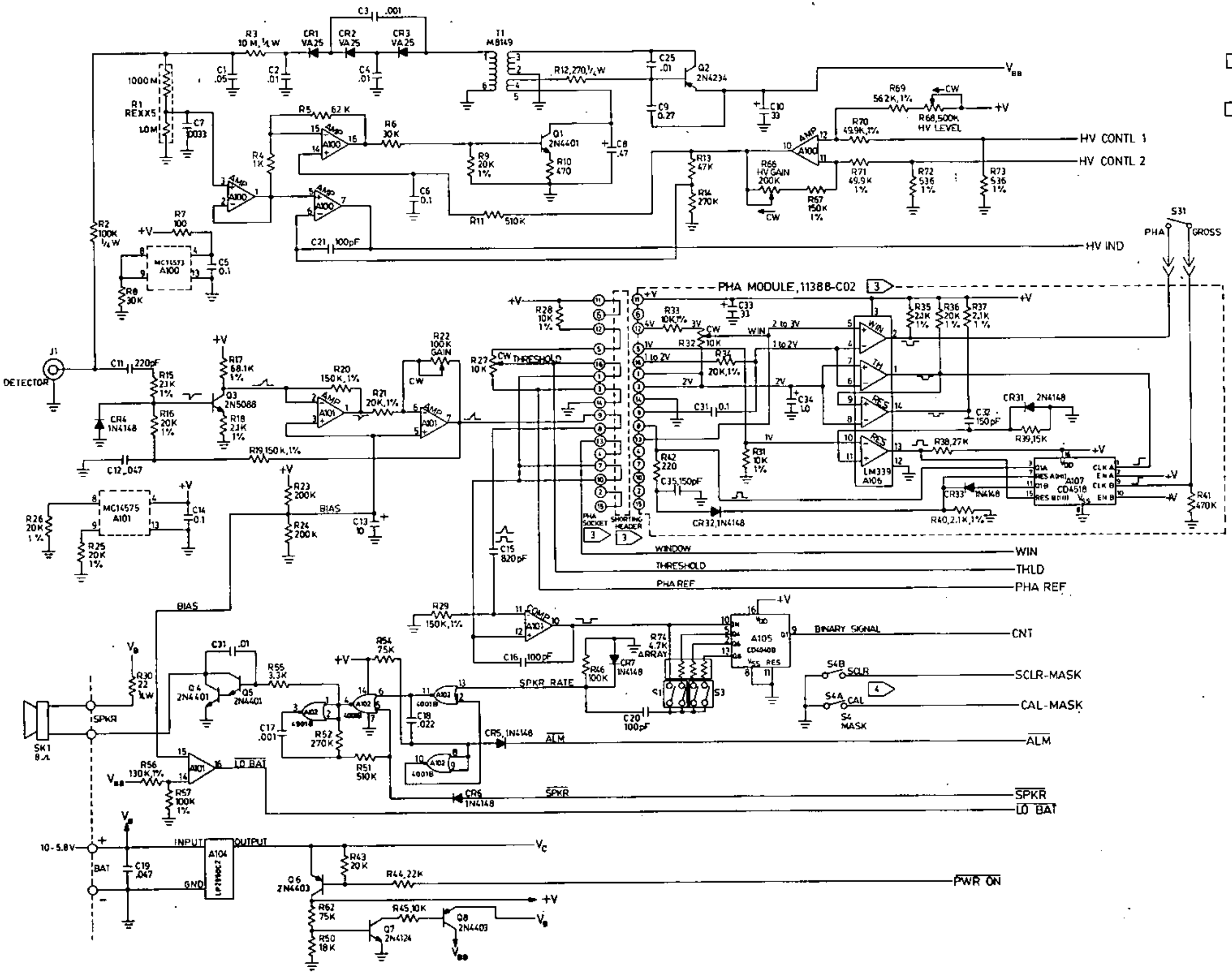


Figure 7-7, Component Layout DC Power Supply Board, 11341-C07



NOTES:

1. CAPACITANCE IS IN MICROFARADS UNLESS OTHERWISE NOTED.
2. RESISTANCE IS IN OHMS UNLESS OTHERWISE NOTED.

3 THE PHA SOCKET MUST HAVE EITHER THE PHA MODULE INSTALLED (FOR PULSE HEIGHT ANALYSIS) OR THE SHORTING HEADER INSTALLED (NO PHA).

4 S4A & S4B ARE NON-FUNCTIONAL WHEN THIS ESP BASIC PCB IS USED IN AN ESP-2. THEY ARE NOT INSTALLED FOR ESP-2 USE & JUMPERS X TO Y & Z TO W (SEE SHEET 2) ARE NOT INSTALLED.

Figure 7-9. Microcomputer Schematic, 11384-D03F (Sheet 1 of 2)

SEE SHEET 1 FOR NOTES

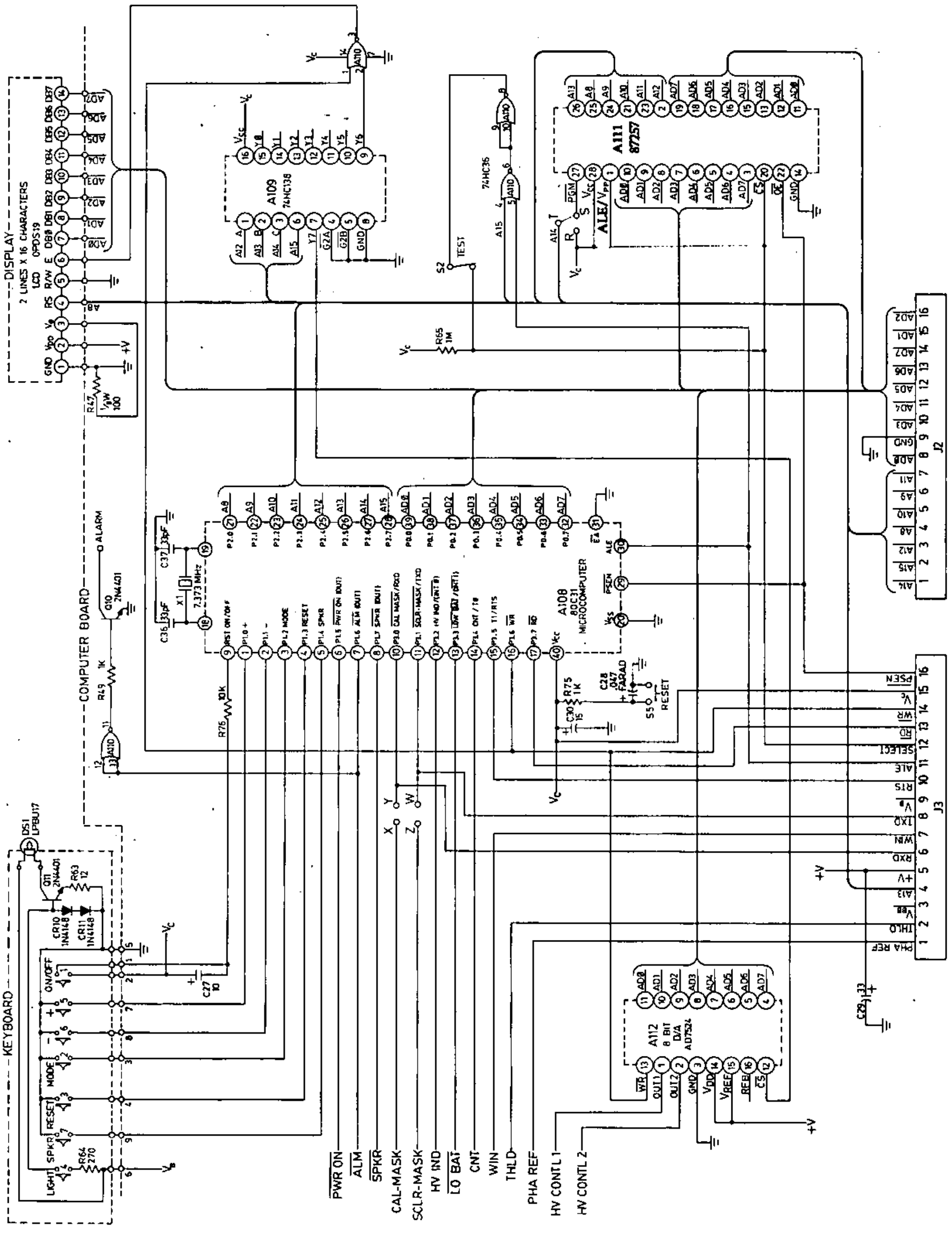
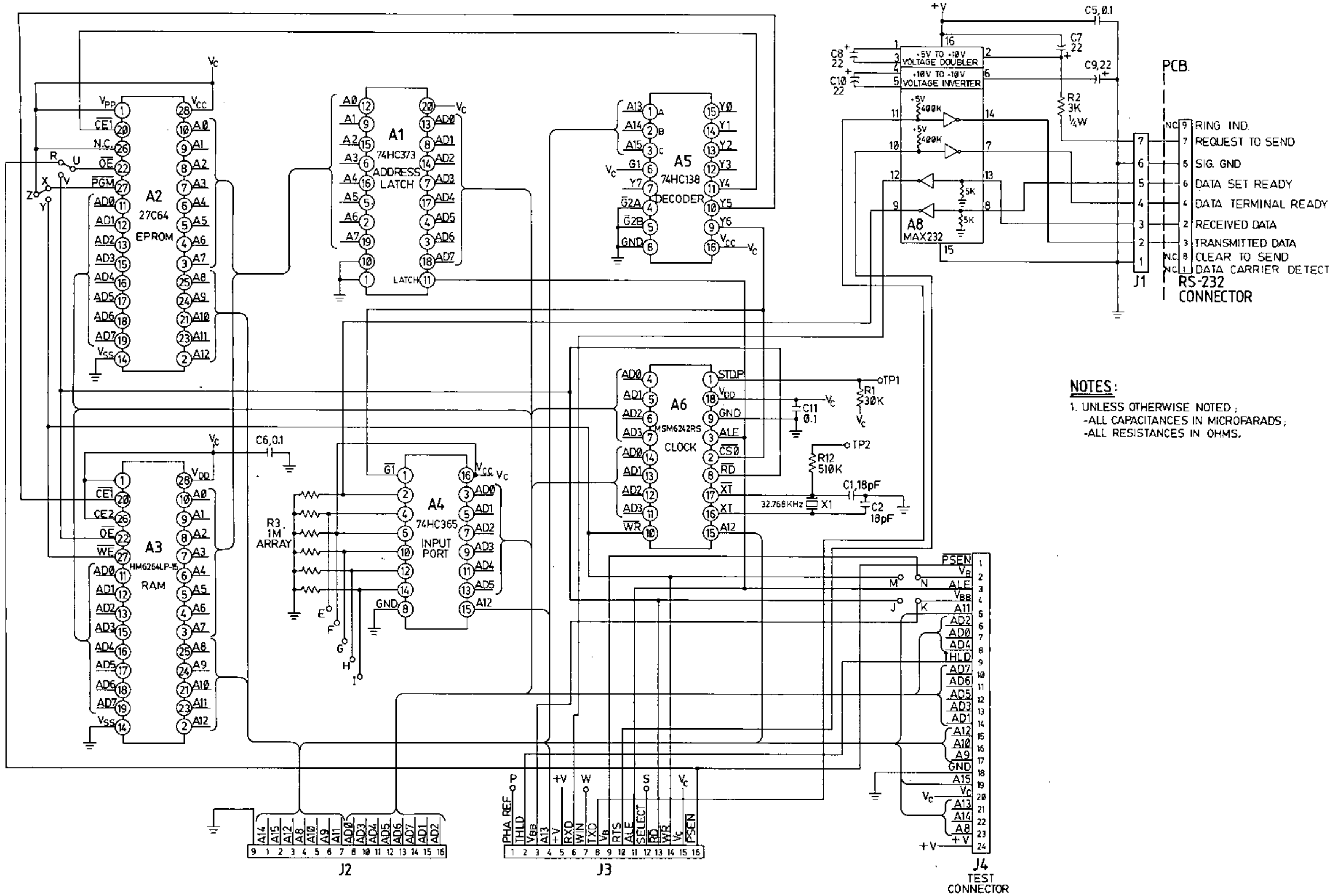
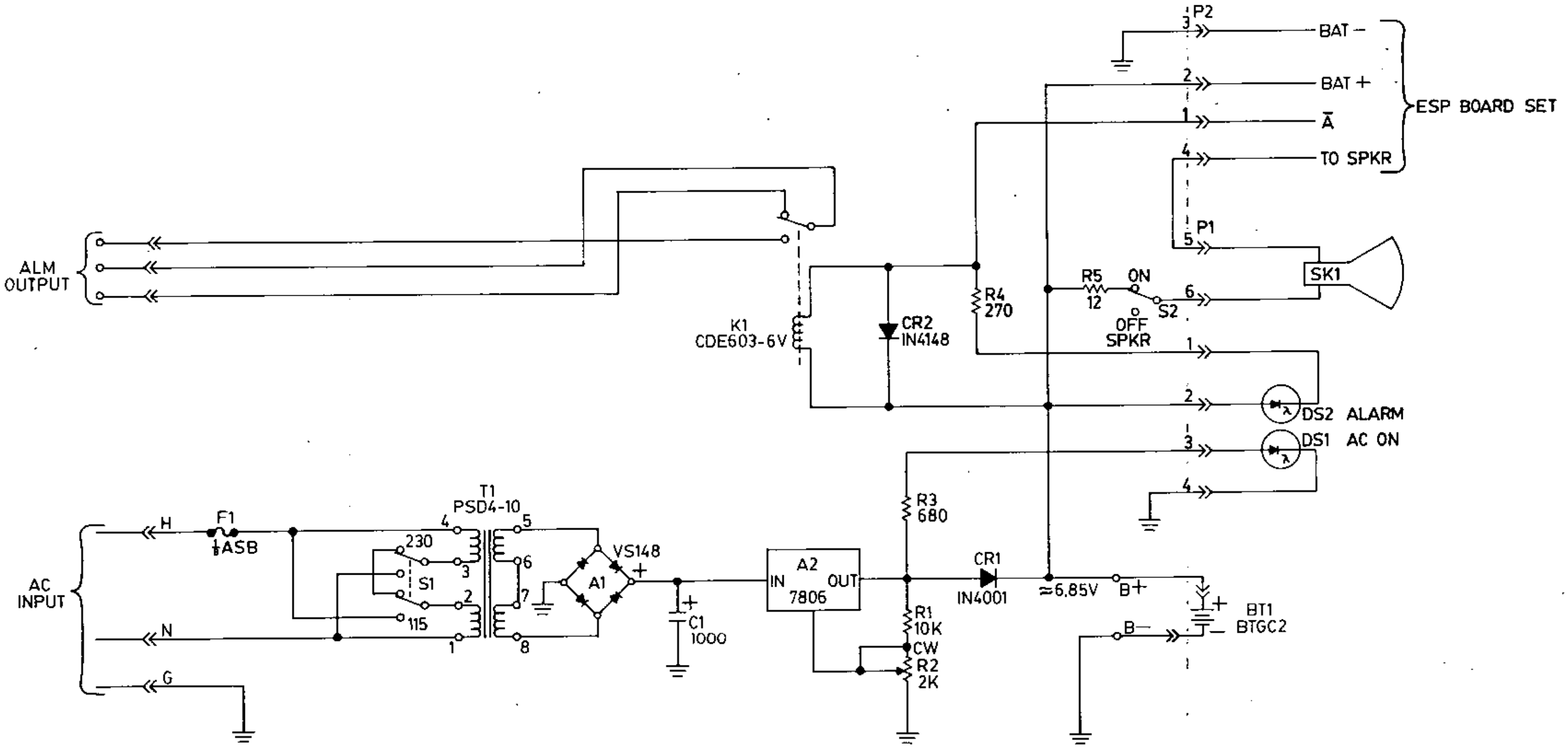


Figure 7-9. Microcomputer Schematic, 11384-D03F (Sheet 2 of 2)



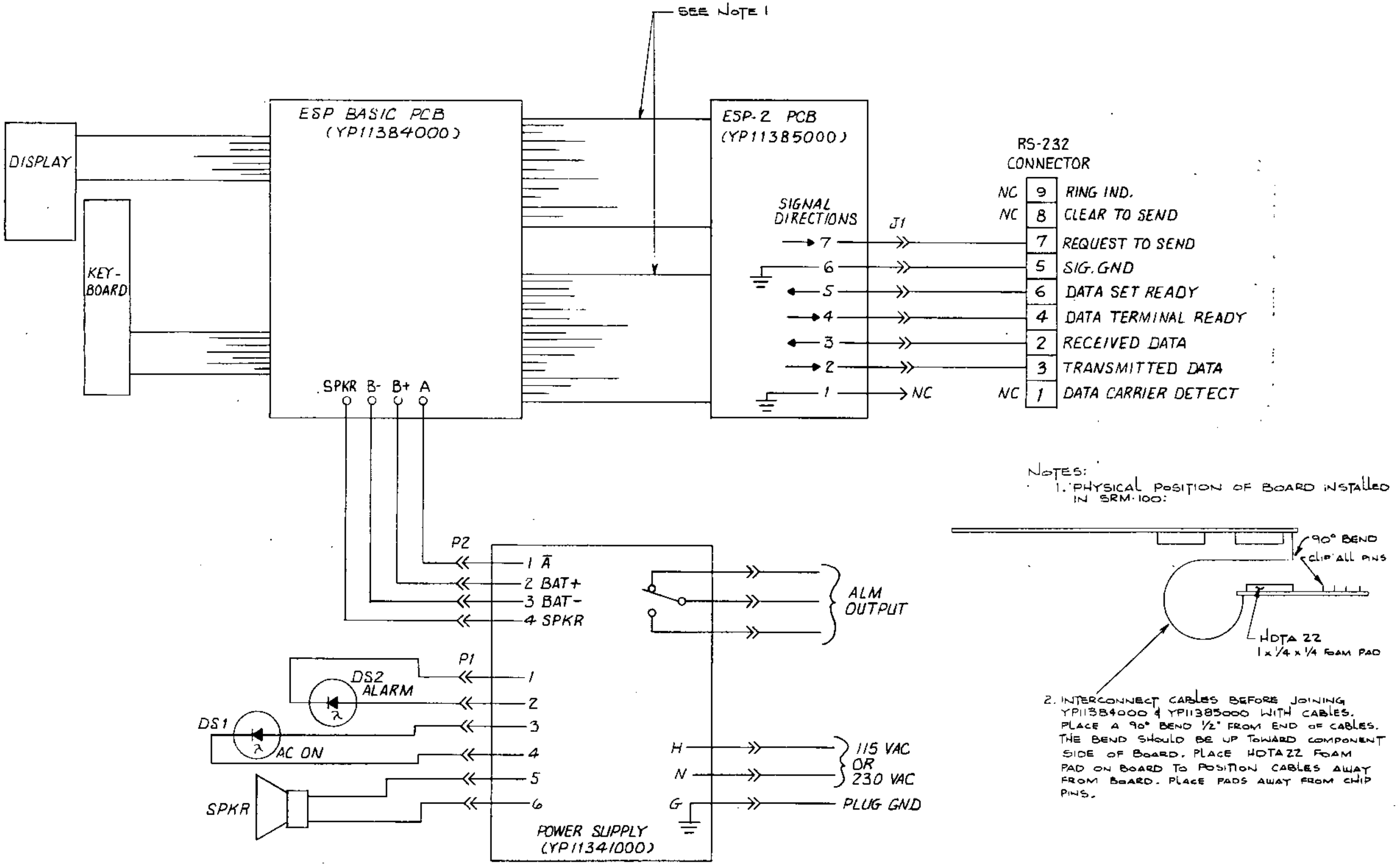
NOTES:
1. UNLESS OTHERWISE NOTED;
-ALL CAPACITANCES IN MICROFARADS;
-ALL RESISTANCES IN OHMS.

Figure 7-10, ESP-2 PC Board Schematic, 11385-D03C



NOTES :
1. UNLESS OTHERWISE NOTED:
-ALL CAPACITANCES IN MICROFARADS,
-ALL RESISTANCES IN OHMS.

Figure 7-11, DC Power Supply Schematic, 11341-D05C



NOTES:

1. PHYSICAL POSITION OF BOARD INSTALLED IN SRM-100:
2. INTERCONNECT CABLES BEFORE JOINING YP11384000 & YP11385000 WITH CABLES. PLACE A 90° BEND 1/2" FROM END OF CABLES. THE BEND SHOULD BE UP TOWARD COMPONENT SIDE OF BOARD. PLACE HOTA22 FOAM PAD ON BOARD TO POSITION CABLES AWAY FROM BOARD. PLACE PADS AWAY FROM CHIP PINS.

Figure 7-12, Wiring Diagram, SRM-200, 11395-D50B

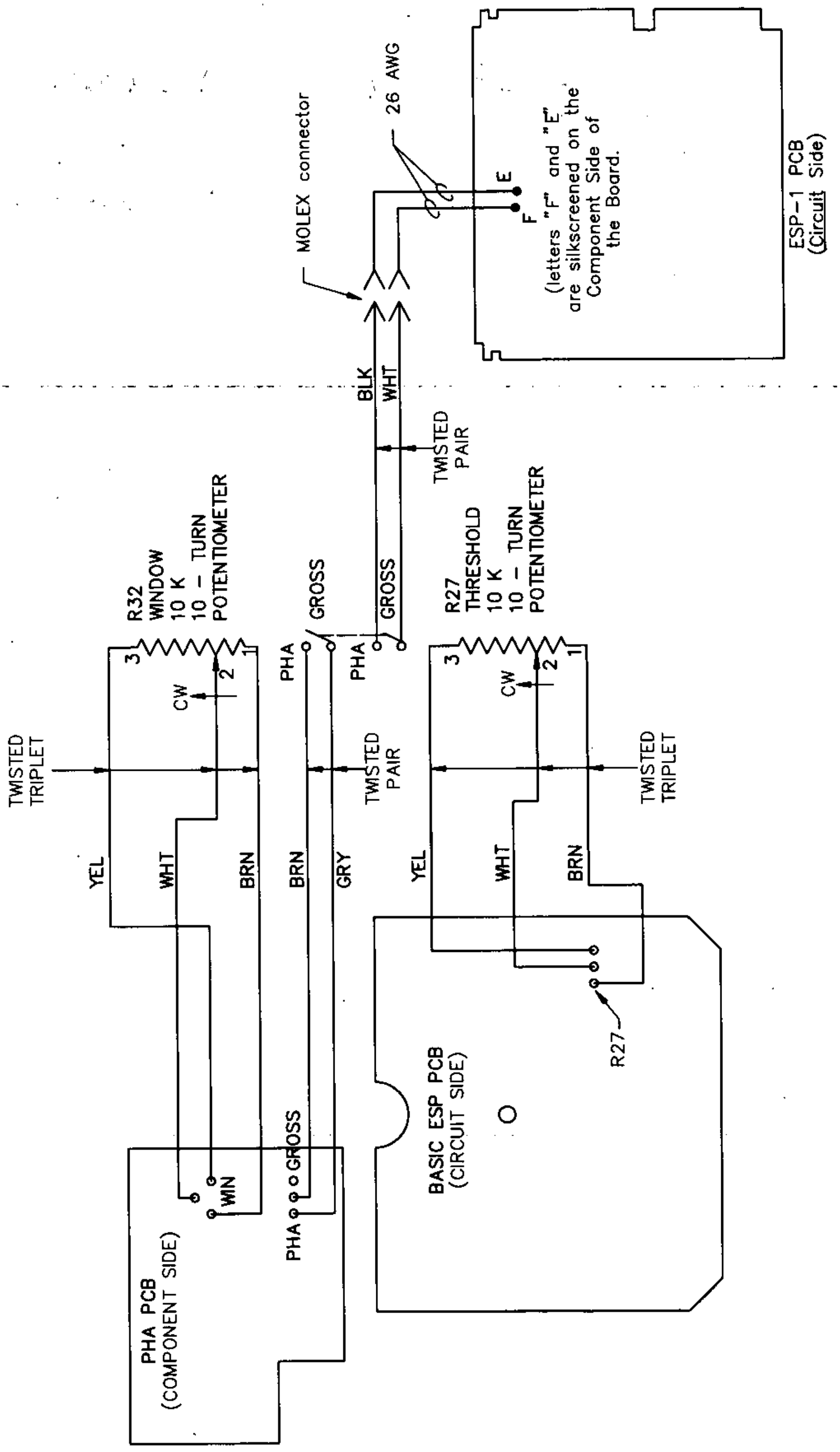


Figure 7-13, Wiring Diagram, SRM-200 PHA Option, 11395-C52A

Section 8

SECTION VIII

DETECTORS AND ACCESSORIES

Table 8-1. Detectors Recommended for Use with SRM-200

Model No.	Type Measurement	Useful Range
AC-3	Alpha Contamination	Background to 33,000 cnt/s
HP-100A	Alpha, Beta, Gamma Contamination	Background to 33,000 cnt/s
HP-190A	Beta-gamma Contamination 1 1/8 inch window	Background to 25,000 cnt/s
HP-210	Beta-gamma Contamination 2 inch window	Background to 66,000 cnt/s
HP-220A	Gamma Exposure or Exposure Rate Directional Shield	Background to 200 R/h
HP-230A	Beta-Gamma Contamination 7/8 inch window	Background to 1000 mR/h
HP-260	Beta-gamma Contamination	Background to 66,000 cnt/s
HP-270	Gamma Exposure or Exposure Rate	Background to 2500 mR/h
HP-280	Neutron Flux (used with NRD)	Background to 44,000 cnts/s
HP-290	Gamma Exposure or Exposure Rate	0.005 to 50 R/h
LEG-1	Low Energy Gamma or X-Ray 20 to 70 KeV	Background to 33,000 cnt/s
NRD	Neutron Dose Equivalent or Dose Equivalent Rate	0.001 to 60 rem/h
PG-2	High Sensitivity Gamma 10 KeV to 100 KeV	Background to 25k cnts/s
RD-14	Alpha or Beta Filter Samples Up to 4 1/2 inch diameter	Background to 33,000 cnts/s
SAC-R5	Lucas Cell Counter	Background to 33,000 cnts/s
SPA-1A	Alpha Filter Samples	Background to 50,000 cnts/s
SPA-3	High Sensitivity Gamma 40 KeV to 1 MeV	Background to 25,000 cnt/s
SPA-6	Medium Sensitivity Gamma 40 KeV to 1 MeV	Background to 25,000 cnt/s
SPA-8	Medium Sensitivity Gamma 40 KeV to 400 KeV	Background to 25,000 cnts/s
SPA-9	High Sensitivity Gamma 40 KeV to 250 KeV	Background to 25k cnts/s
WAM-4	4π Gamma	Background to 33,000 cnts/s